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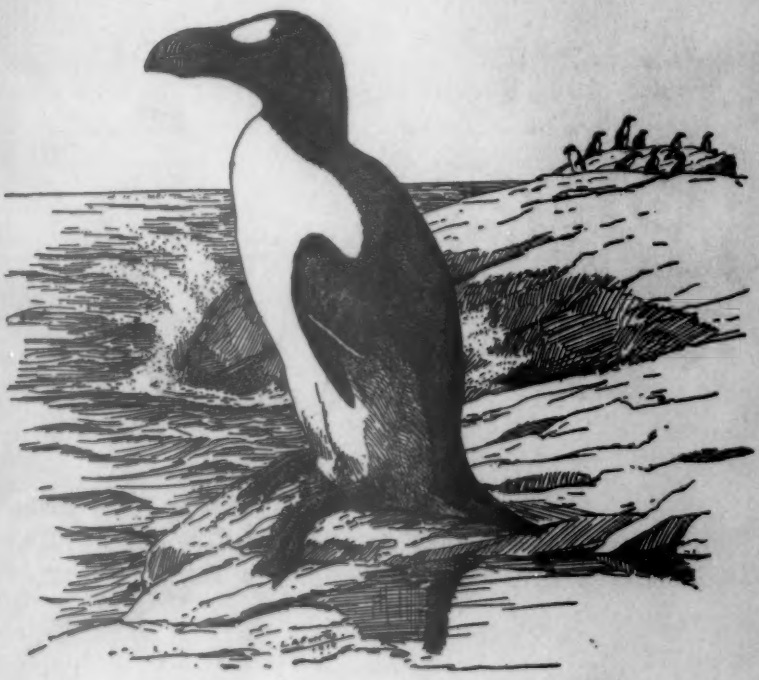

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THE AUK

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NOTES ON BEHAVIOR AND ABUNDANCE OF THE BLACK-FOOTED ALBATROSSES IN THE PACIFIC WATERS OFF THE CONTINENTAL NORTH AMERICAN SHORES

BY CHARLES YOCOM

Plate 17

INTRODUCTION

SEVERAL ornithologists, among them Miller (Condor, 38: 9–16, 1936; *op. cit.*, 42: 229–238, 1940; *op. cit.*, 44: 3–9, 1942), Anthony (Condor 26: 33, 1924), and Willett (Condor, 39: 226, 1937), have reported upon the Black-footed Albatross (*Diomedea nigripes*). Though many 'sea stories' mention the albatross, and though thousands of service men have seen this interesting bird follow transports and fighting ships during the recent war, few ornithologists seem to have had opportunity to study them at any length in the open sea. I had just such an opportunity when assigned for duty aboard a ship February 22, 1945. The nature of the duty was such that our ship remained in a given area for about twenty-five days before being relieved. Five trips in all were made while I was aboard, which included parts of seven months (Feb. 23, 1945, to Sept. 15, 1945).

Area studied.—Four different areas were visited; the centers of the areas and the dates of tour are as follows:

Area	*Location*	*Dates*
1	34° 40′ N.; 129° 50′ W. (400 nautical miles from San Francisco, Calif.)	April 10 to May 1 May 24 to June 15
2	34° N.; 131° 31′ W. (500 nautical miles from San Francisco, Calif.)	Feb. 24 to March 19

Area	*Location*	*Dates*
3	31° 40′ N.; 136° W. (800 nautical miles from San Francisco, Calif.)	July 22 to July 27
4	43° N.; 135° W. (465 nautical miles west of Cape Blenco, Oregon)	July 8 to July 19 Aug. 23 to Sept. 12

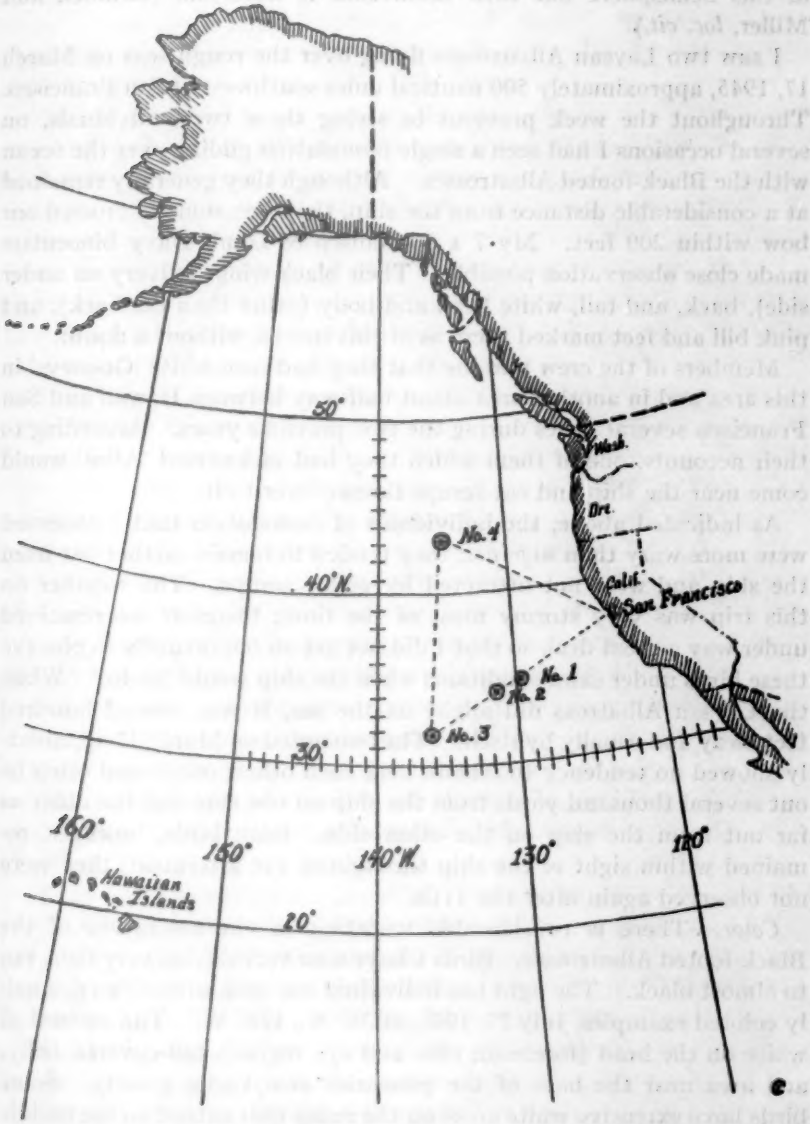
The map (*see* Text-fig. 1) shows the areas covered, which embrace a large, triangular region with its apex at San Francisco, California. The center of area No. 4 was approximately 465 nautical miles directly west from Point Blenco, Oregon, and 490 nautical miles southwest of Straits of San Juan de Fuca, Washington. No. 3 was 800 nautical miles southwest of San Francisco, and due west of northern Lower California.

In general, we went directly to an area from our base in San Francisco Bay and returned by the same route about a month later. On one occasion we proceeded to No. 4 where we remained for a time and then steamed to No. 3. This afforded the chance for me to observe the waters along the western edge of the triangle.

The region covered embraces approximately eleven degrees and twenty minutes of latitude (680 nautical miles), and thirteen degrees, twenty-five minutes of longitude of open ocean. The only observations made along the continental shelf were those in going to and returning from the areas.

CHARACTERISTICS

The Black-footed Albatross (*Diomedea nigripes*), or 'Gooney' as it is usually known by the sailors, is one of three Pacific species found in numbers north of the equator. The other two are the Short-tailed Albatross (*Diomedea albatrus*) and the Laysan Albatross (*Diomedea immutabilis*). The former species is now probably extinct; the last positively identified specimen from California was taken at San Pedro, Los Angeles County, April 3, 1898 (Willett, Pac. Coast Avif., 21: 14, 1933). *Immutabilis* is listed as a rare or casual visitant to California waters (Grinnell and Miller, Pac. Coast Avif., 27: 1–608, 1944). There is only one definite record for California, but there are records for it far off the coastal waters: one sighted approximately 1060 miles west of Cape Mendocino, October 31, 1880 (Bean, Proc. U. S. Nat. Mus., 5: 170, 1882) and two seen about 700 miles southwest of San Francisco, April 8, 1913 (Willett, Condor, 15: 158, 1913). Loomis [Proc. Calif. Acad. Sci., (Ser. 4) 2: 83, 1918] tells of another one shot at 33° 07′ N., 134° W., November 14, 1906, and others seen within about 500 miles of San Francisco. Species other than these three have been reported



TEXT-FIGURE 1.—Region in which observations were made on the Black-footed Albatrosses from February 23 to September 15, 1945. ⊙ = Areas where long periods of observations were made. ------- = Waters passed through.

in this hemisphere but their occurrence is uncertain (Grinnell and Miller, *loc. cit.*).

I saw two Laysan Albatrosses flying over the rough seas on March 17, 1945, approximately 500 nautical miles southwest of San Francisco. Throughout the week previous to seeing these two individuals, on several occasions I had seen a single *immutabilis* gliding over the ocean with the Black-footed Albatrosses. Although they generally remained at a considerable distance from the ship, they occasionally crossed our bow within 200 feet. My 7 x 50 Bausch & Lomb Navy binoculars made close observation possible. Their black wings (silvery on under side), back, and tail, white head and body (other than the back), and pink bill and feet marked them as of this species without a doubt.

Members of the crew told me that they had seen white 'Gooneys' in this area and in another area about half-way between Hawaii and San Francisco several times during the two previous years. According to their accounts, one of them which they had nicknamed 'Alice' would come near the ship and eat scraps thrown over to it.

As indicated above, the individuals of *immutabilis* that I observed were more wary than *nigripes;* they tended to remain farther out from the ship and were not attracted by galley scraps. The weather on this trip was very stormy most of the time; therefore we remained under way a great deal, so that I did not get an opportunity to observe these birds under calm conditions when the ship would 'lie-to.' When the Laysan Albatross did alight on the sea, it was several hundred feet away and usually by itself. The two noted on March 17 apparently showed no tendency to remain near each other; one would often be out several thousand yards from the ship on one side and the other as far out from the ship on the other side. Both birds, however, remained within sight of the ship throughout the afternoon; they were not observed again after the 17th.

Color.—There is considerable variation in the coloration of the Black-footed Albatrosses. Birds I have seen varied from very light tan to almost black. The light tan individual was seen with seven normally colored examples, July 29, 1945, at 35° N., 128° W. The amount of white on the head (forehead, chin and eye region), tail-coverts, belly, and area near the base of the primaries also varies greatly. Some birds have extensive white areas on the rump that extend to the middle of the breast. Some have no white in these areas, and others show only a few white feathers among the dark ones. Most, if not all, of the albatrosses have white areas at the base of their bills. In some this white area extends to the middle of the crown, around the eye and through the throat region to the neck; in others no white is apparent

except for a small margin around the base of the bill. This white margin often is not visible except at close range. All *nigripes* have dark feet and bills; there is a tendency however, for the bills to vary slightly in shade.

Data from five trips show that the ratio of the white-rumped to dark-rumped birds varied between 1:8 and 1:10, and that the ratio changed little between seasons or areas. Making accurate counts for determining ratios was more difficult than one would assume, for white-rumped birds resting on the sea could not be distinguished from dark ones except when they were very close to the ship. When in flight, however, white-rumped birds could easily be determined when in the proper position. Another difficulty in getting accurate counts was that only during stormy weather would most of the albatrosses be in flight and then many of them would be ranging far out from the ship. Those that were close would be continually shifting from port to starboard and vice versa. An albatross approaching head-on, moreover, could not be placed definitely as to rump color. Miller (Condor, 42: 229–238, 1940) estimated that approximately ten per cent of the albatrosses that he observed were white-rumped.

I am of the opinion that the white areas become more extensive as the molting season approaches owing to wearing of feathers and bleaching of pigment. The plumage of molting birds becomes mottled as the new darker feathers replace those worn and bleached.

I was unable to distingush between male and female birds either by color or actions. I am in accord with Miller's (Condor 42: 229–238, 1940) statement:

"I am inclined to believe that this species, like so many other 'tube-noses,' has a wide range of color that is independent of sex, season, or age."

Size.—The seemingly never-ending seas, the unbroken horizon, and the ocean swells distort one's perspective of size. A sailor standing on the fantail of his ship watching the 'Gooneys' swing over the wake, never would guess that the bird in which he is so interested has a wing-spread of seven feet and a body length of nearly two and one-half feet. Only when your ship is 'lying-to' or when a petrel, shearwater or phalarope flies near this bird does one realize its large size.

On our last trip to Station 4 (August 23 to September 12) I had been furnished bands by the Fish and Wildlife Service; the measurements of the three albatrosses that were banded and a fourth one (now in the Museum of the State College of Washington) which was accidentally killed are as follows:

Tip of bill to tip of tail	*Wing-spread*	*Culmen*	*Band-number*
28 in.	80 in.	3.75 in.	44-711602
28.5 in.	76 in.	3.75 in.	44-711603
25 in.	85 in.	4.0 in.	44-711604
27 in.	84 in.	3.75 in.	none

No scales were available, but the weights of those birds handled were estimated to be six pounds. The specimen skinned had considerable fat over most of the body, particularly on the belly, breast and rump.

Flight.—No other bird (possibly the shearwaters excepted) has ever impressed me as being so completely in its element as the albatross when the sea is whipped to a frenzy by storm. Its long, slender wings carry it in perfect balance and grace, first down in the troughs of the waves then up rapidly to as high as 100 feet, on occasions, as it swings directly into the gale, then banks to make a long downward glide, first at right angles to the wind then with it. Often it is completely lost from sight as it glides within inches of the waves and disappears behind another swell only to reappear again, gliding in towards the ship. In the ocean gales or on the turbulant waves it is equally at home.

The larger albatrosses are credited with sailing for long periods of time without flapping their wings; this does not hold true, however, with *nigripes*, even in strong winds. My data on recorded time between wing strokes varies from ten to forty-five seconds, the latter during a fourteen-knot wind. This is no discredit to their mastery of flight, however, for I have seen them apparently enjoying fully a fifty-five knot gale (which was not the case with the ship's crew).

No accurate method was available to determine the exact speed of flight of this species. The ship was equipped with radar and the reflected radar waves from flocks of resting albatrosses were often picked up on the screen, but we were never able to trace them in flight. This has been done, however, by certain types of radar (Buss, Auk, 63: 315–318, 1946; Lack, Nature, 156: 446, 1945; McKay, Nature, 156: 629, 1945). My observations lead me to believe that Black-footed Albatrosses glide over the sea between twenty-four and thirty-two knots (27.6+ to 36.8+ land miles per hour). Our ship under *standard speed* made eleven knots (12.7 m.p.h.); I have seen albatrosses glide past when we were at *standard speed*, then circle out to our beam and on out over the sea for a quarter of a mile or more, then quickly overtake us again. The wind velocity, of course, influences the speed of the birds.

The 'Gooneys'' manner of taking flight varied with weather conditions. During storms they simply rode to the crest of a wave, spread

their wings and took off. On calm days, they expended considerable effort in launching; they spread their long, narrow wings, paddled vigorously with their large webbed feet, and made long awkward strokes with their wings until they actually ran over the water, much like a sea plane 'taking off.' At times they ran one hundred feet before clearing the water, but twenty-five to fifty-foot runs were more common. Calm weather by no means restricts these birds to the water, even though they are most active on stormy days.

As soon as the albatross is air-borne, the feet are carried flat against the body with the webbed toes reaching a little beyond the tail. The feet appear to be used as rudders or as an aid for balance when the bird turns. In landing, the feet, with toes spread, are extended forward towards the water (See Plate 17, upper fig.) and act both as skids and as brakes when contact is made with the surface. On days with brisk winds, I saw albatrosses extend their feet as if to land but seemingly walk on the crest of a wave without actually alighting. I have also seen them skid along the side of an ocean swell with one foot extended as they glided down into a trough. Frequently the tip of one wing would slice along the edge of a wave as the birds flew within inches of the surface.

A general rush for the scraps resulted when galley refuse was thrown overboard. Birds far out flew in to get their share, but birds within two or three hundred yards of the ship often would not bother to launch themselves but flapped and paddled over the water to the food.

When there was a wind or just a slight breeze blowing, 'Gooneys' faithfully stayed on the windward side of the ship; only rarely would one swim to the leeward side. I assume that the main reason for their staying on the windward side was to facilitate quicker 'take-offs' in case they desired to fly. They usually faced the wind and waves during a rough sea.

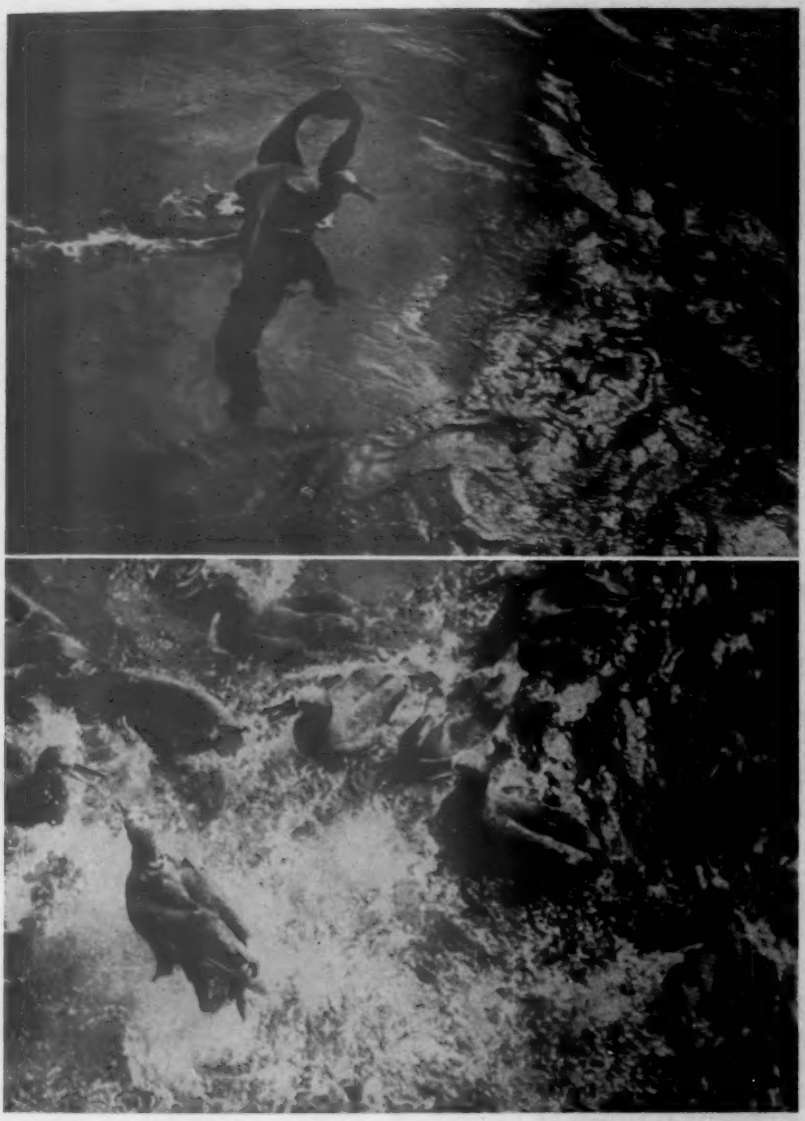
Calls and other activities.—The general impression that many ocean voyagers have of the Black-footed Albatross is of a quiet bird with solitary habits. From a ship 'under way' one seldom sees more than six albatrosses following over the wake (more often the number is between one and three) and seldom does one hear them utter any calls. On the other hand, when an observer has the opportunity to be at sea on a ship 'lying-to' for a period of time, his impression changes. About our stationary ship, at least, large flocks of albatrosses were our constant companions. When food was the subject of dispute, these birds uttered loud, shrill screams or screeches which attracted others of their kind far out from the ship. Bent (U. S. Nat. Mus., Bull. 121: 1–343, 1922) refers to this call as a "whirring groan."

Often when an individual had a choice morsel and desired to keep competitors at a distance, it would spread its wings, open wide its bill, and give forth a series of screams which were louder and higher-pitched than the noise made by domestic pigeons waiting to be fed.

Black-footed Albatrosses were often noted in groups of two, three, and four, performing a sort of dance which may be associated with courtship. After the 'chit chats,' which usually lasted from one to fifteen minutes, were completed, the involved birds went separate ways and paid no further attention to each other. I saw no indications of pairing except under these circumstances. Because these performances were observed on every trip from February to September, it seems doubtful if they are courtship acts. This species, as well as others in the northern hemisphere, breeds during the northern winter months as do their Antarctic relatives (which would be in the southern summer). Black-footed Albatrosses arrive early in November on the islands of the Hawaiian group (Laysan, Gasper Rico, Midway, Marshall, Volcano, and Bonin Islands) to breed, according to Bent (U. S. Nat. Mus., Bull. 121: 1–343, 1922). There appeared to be no correlation with sex or display to ward off other birds from a given area. As a matter of fact I was not certain if males, females or both participated in these so-called 'dances' because I could not distinguish male from female. Possibly it is only a manifestation of a strong social impulse, for individuals occasionally swim close together and rub beaks or caress each other about the neck and head.

This so-called 'dance,' or 'chit chat' as the sailors sometimes called it, consists of a series of exchanged calls similar to those made by goslings when being hovered. This may or may not be supplemented by shaking of heads from side to side or tilting the heads and bills almost perpendicularly to the body axis. Between calls one of the birds or both may make a series of cracking or snapping noises with the bill similar to noises made by young owls and domestic pigeons when molested. On three occasions I noted one of a pair make a series of jumps backwards. This was accomplished by thrusting the feet (toes widely spread) forwards and downwards very rapidly—both feet moved simultaneously. At times this procedure is altered somewhat by one of the birds lifting its wings high over its back and pecking the under wing-coverts. Another part of the 'chit chat' often finds one of the birds stretching its head and neck far out towards the other bird which usually gently pecks the extended head.

On several occasions albatrosses were brought aboard the ship, but none of these birds made any sounds, yet they were well able to defend themselves with their strong, sharp bills. They were unable to fly



(*Upper*) BLACK-FOOTED ALBATROSS LANDING IN THE WAKE OF THE SHIP. NOTE HOW THE WINGS ARE HELD ARCHED AND THE FEET FORWARD AS THE BIRD SKIDS ALONG THE SURFACE OF THE WATER. (*Lower*) LUNCH TIME. THESE BLACK-FOOTED ALBATROSSES COLLECTED ABOUT THE FANTAIL OF OUR SHIP TO GET THEIR PORTION OF THE GALLEY SCRAPS WHICH HAD BEEN THROWN OVERBOARD JUST BEFORE THE PICTURE WAS TAKEN. THE BIRD IN THE LOWER RIGHT-HAND CORNER HAD DIVED FOR THE SCRAP OF FOOD WHICH IT HAS IN ITS MOUTH. THE OTHERS WITH OPEN MOUTHS ARE SCREAMING.

from the deck and were extremely awkward in their movements aboard ship. In some cases the captured albatross regurgitated the stomach contents and appeared seasick from the ship's movement.

Albatrosses, on the whole, are sociable birds that fight little among themselves (except over ship's refuse) or with other species. On calm days large groups congregate in rafts and peacefully loiter away most of an afternoon floating sometimes as far as a mile away from the ship. Individuals join and depart from the raft at will.

They are curious birds and are attracted to any box, plank or floating object that comes along. Japanese fishing balls were sighted by men because 'Gooneys' collected about them. A floating box often formed the nucleus of a loitering flock of Black-foots. During the evening of July 16, as we were 'under way,' a group of albatrosses was sighted massed about a floating object. Upon steaming alongside we found it to be a life raft which had been drifting for some time, judging from the number of attached barnacles. Fifteen albatrosses had collected around this raft, and as we steamed on again a group of them was noted to remain about it. I assume that they may have remained about this raft until dark.

On calm days, a rubber life raft could be paddled amongst a flock of loitering albatrosses; some of the birds would come close enough to inspect the paddles if no quick movements were made. They would not allow a man, however, to swim near them.

Food habits.—Miller (Condor, 42: 229–238, 1940) found squid beaks in all stomachs examined, large fish bones in one, great masses of eggs in two, and tips of *Macrocystis* (a seaweed) in another. His impression of the Black-footed Albatross' food habits was that it is a "feathered pig" and would eat various foods thrown overboard. Bent (U. S. Nat. Mus., Bull. 121: 1–343, 1922) quotes as follows: "It is said by Baird, Brewer, and Ridgway (1884) to feed largely on a pelagic crab." Fisher (Condor, 47: 128–129, 1945) reported albatrosses capturing flying fish. A member of our crew also observed an albatross catch a flying fish that had flown from the path of the ship (position approximately 30° N., 140° W.). The capture was made as the fish re-entered the water. An albatross which was lassoed and brought aboard regurgitated an eight-inch fish, bones of another fish, and remains of squid.

All of the Black-foots which collected about our ship quarreled and scrambled for galley scraps (See Plate 17, lower fig.). They ate all kinds of meats (fats in particular), cereals, pancakes, bread, and other pastries, but would not touch fruits unless they were cooked, except for an occasional apple core. Half-pound chunks of fresh shark meat which were thrown overboard to them were swallowed in one gulp.

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Of all the gleanings, fats were their choice. Occasionally individuals would dive below the water surface for food; the usual procedure, however, was to tip in a manner similar to that of river ducks. When scraps of food were thrown directly off the fantail of our moving ship, the whirling current created by the twin screws often sucked some of the scraps far below the surface. Occasionally an albatross which had attempted to secure the food would be caught in the current and forced several feet under water; this apparently disturbed it little for upon its returning to the surface one could often see it swallow some scraps which it had obtained.

I have often watched compact groups remain on the water until darkness prohibited observations. Furthermore, the radar screen occasionally indicated that they remained in groups after nightfall, but at other times they became very active as darkness approached. I am of the opinion that these birds forage for their natural foods throughout the night and, presumably, are more active during early morning hours. When on night watches on moonlight nights I have often seen albatrosses fly past the ship in what I assumed to be their nightly hunts. The silhouettes of albatrosses often passed across the rising or setting moon. My morning observations lead me to conclude that albatrosses hunt most during the early morning hours. While on early morning watches, I never observed large flocks of resting albatrosses; as the morning progressed the number of birds gradually increased as one, two, or more birds came gliding over the ocean from all points of the compass to collect about the ship. Occasionally not a single albatross would be within a mile of the ship at dawn, but by means of binoculars or spotting scope, one could often note them flying over the ocean four to six miles away. By sunrise there usually would be a group gathered near by ready to quarrel over any galley refuse that might be thrown overboard.

DISTRIBUTION AND ABUNDANCE

As previously mentioned, *D. nigripes* nests in the Hawaiian Island group, but young and adults range over the North Pacific Ocean mainly north of the Tropic of Cancer to the Aleutian Islands and southern areas of the Bering Sea, southward along the North American coast from Alaska to Lower California, west to Formosa Channel, Japan, and the Kurile Islands (Bent, U. S. Nat. Mus., Bull. 121: 1–343, 1922). Banding returns indicate the vast areas covered by this sea traveler. Cooke (Bird-Banding, 14: 67–74, 1913) lists records on two returns of young albatrosses banded on Sand Island, Midway Station, Pacific Ocean. One banded on December 25, 1940, by G. C. Munro,

was caught on a fish line near Cape Omaney, Alaska, July 22, 1942; the other bird, banded two days later at the same place, was found dead near Yachato, Oregon, May 27, 1942. Still another Black-footed Albatross, banded on the same date and at the same island, was caught May 23, 1941, by a sailor on a Japanese steamship, Kaihoku-Maru, at 148° 30′ E., 37° 30′ N. about 500 miles northeast of Tokio—an airline distance of at least 2,200 miles (Cooke, Bird-Banding, 16: 105, 1945).

Miller (Condor, 42: 229–238, 1940) points out that *nigripes* is not a channel bird but is found in greatest numbers in the cooler waters outside the channels. He also states: "On passing out to sea into the warmer oceanic waters, one finds their numbers dropping down almost to zero."

My observations along the continental shelf were limited in scope and time for I was in such waters only in going to, and returning from, areas far at sea; I did not note, however, a similar concentration of albatrosses in this restricted region. My conclusions were that these birds were quite uniformly distributed over all of the waters through which we steamed. Rarely would more than six birds follow our ship (usually one to four) but, on the other hand, rare was the occasion when an albatross could not be seen from the ship. Our courses along the southern boundary of the triangular area were several miles south of the Great Circle routes and the others were far from well-traveled shipping routes. Thus albatrosses should not have been concentrated along our courses owing to frequent traveling by other ships. On each trip to sea, albatrosses were sighted soon after we had left the Golden Gate. My record for the closest observation near land was one bird sighted twelve miles out from the Golden Gate Bridge. They were our constant companions (except on rare occasions) from the shallow waters around the Farallon Islands until we returned.

It is my opinion, however, that a single bird would follow our ship for relatively short distances. Miller (Condor, 44: 3–9, 1942) found that out of twenty-five albatrosses marked at sea off of the coast of southern California, only one repeated at fifty and sixty miles, three at forty miles, seven at thirty miles, and twelve at twenty miles. The birds that followed us were not marked, but often one of the birds would be white-rumped. By watching white-rumped individuals I was able to estimate how long individuals would follow the ship. My conclusions were that most albatrosses did not follow the ship for more than four to six hours. Since we made twelve knots, this would indicate that individual birds had ranges not more than 60 miles in diameter. This is not conclusive evidence that albatrosses have individual

or home ranges over certain areas on the ocean but does suggest that such might be the case. On the other hand, large numbers of albatrosses collected about the ship when 'lying-to.' Usually only two or three albatrosses would be around the ship when we arrived at our destination but within a day's time many would have collected about us. In this case the ship appeared to be the hub of activity for these birds. The daily available food from galley scraps may have attracted these birds from distant areas. The constant supply of food, the stationary ship and their apparent social tendencies may have created an unusual situation which disrupted albatrosses' usual distribution.

Abundance.—Many factors affected the number of birds seen each day. At times stormy weather caused us to get 'under way,' ocean currents caused us to drift, and occasionally we would move our position during the day or night. Weather conditions and the time of day also affected the movement of the birds. One hundred and twenty-five albatrosses were sighted and counted by one of the ship's crew, July, 1944, when in an area approximately 1000 miles southwest of San Francisco, California. This ship had been in this region for some time.

The maximum numbers of albatrosses in sight at one time at the four different areas (Text-fig. 1) were as follows:

Areas	*1*	*2*	*3*	*4*		
Days at area	Feb. 24 to March 19	April 10 to May 1	May 24 to June 15	July 22 to July 27	July 8 to July 19	Aug. 23 to Sept. 12
Maximum no. Albatrosses seen	65	50	95	73	53	53

Table 1 shows the maximum number of albatrosses counted daily while we were at Area 4 (two trips are included). My notes are not complete enough to include similar data for the other areas. There was, however, a similar fluctuation from day to day. Apparently weather conditions accounted for some of this, since the largest numbers were sighted on calm days when the albatrosses would collect about us in large, loose flocks. On stormy days they would spend more time flying about over the rough seas and would not necessarily remain in the vicinity of the ship as mentioned previously.

In addition to the variation in maximum numbers of albatrosses seen daily there appeared also to be a noticeable daily rhythm as mentioned under food habits. The data on maximum number of birds seen daily indicate this rhythm somewhat, for in most cases the greatest number of birds were seen during the late afternoons. My

TABLE 1

MAXIMUM NUMBER OF BLACK-FOOTED ALBATROSSES SEEN DAILY AT AREA 4 (465 NAUTICAL MILES W. OF POINT BLENCO, OREGON) ON TWO TRIPS

Date	*Maximum no. of birds seen*	*Time of observation*	*Weather*	*Status of ship*
July 8	4	3:00 P. M.	calm	lying-to
9	23	8:00 P. M.	calm	lying-to
10	33	4:00 P. M.	calm	lying-to
11	53	9:00 A. M.	calm	lying-to
12	42	6:00 P. M.	stormy	lying-to
13	36	? P. M.	stormy	lying-to
14	26	? P. M.	stormy	lying-to
15	26	? P. M.	stormy	under way
16	24	8:00 P. M.	stormy	under way
17	24	4:00 P. M.	calm (overcast)	lying-to
18	24	? P. M.	calm	lying-to
Aug. 23	3	1:45 P. M.	stormy	under way
24	25	? P. M.	stormy	under way
25	(no data)		stormy	under way
26	26	? P. M.	stormy	under way
27	26	6:00 P. M.	stormy	under way
28	53	2:00 P. M.	calm	lying-to
29	44	12:00 noon	calm	lying-to
30	(no data)		stormy	lying-to
31	14	1:00 P. M.	stormy	lying-to
Sept. 1	46	7:45 P. M.	calm	lying-to
2	10	? A. M.	stormy	under way
3	(no data)		stormy	under way
4	(no data)		stormy	under way
5	26	7:00 P. M.	calm	lying-to
6	(no data)		calm	lying-to
7	41	8:00 P. M.	calm	lying-to
8	47	4:30 P. M.	calm	lying-to
9	(no data)		calm	lying-to
10	14	4:55 P. M.	calm	lying-to
11	14 +	? P. M.	stormy	lying-to
12	6	9:00 A. M.	stormy	under way

TABLE 2

NUMBER OF ALBATROSSES SIGHTED FROM THE STATIONARY SHIP AT VARIOUS TIMES OF THE DAY

	A. M.				*P. M.*		
Date	6–8	8–10	10–12	12–2	2–4	4–6	6–8
July 9	—	12	—	14	—	23	—
July 10	—	23	—	—	—	33	—
July 17	—	19	—	—	—	24	—
Aug. 24	—	14	—	—	25	25	—
Aug. 28	—	36	—	—	53	—	43
Sept. 1	4	24	—	—	—	—	46
Sept. 5	2	—	20	20	—	—	26

limited data on numbers sighted throughout the day are not extensive enough to include each day, but the data for the following days do suggest similar trends. This rhythm was more evident on calm days than on stormy ones, because the birds did not fly about so much and the ship was stationary.

Although it was impossible to make hourly observations, the data for the above days show how the total number of birds increased to a maximum number in the afternoons. There is reason to believe that these birds would hunt during the night and early morning and then collect again about the ship throughout the day. This was true especially on calm days.

RELATIONSHIPS WITH SEA LIFE

PELAGIC BIRD ASSOCIATIONS

When the ship was at Station 2 from February to March, there were several Herring Gulls (*Larus argentatus*) and two to four immature Glaucous-winged Gulls (*Larus glaucescens*) (the only gulls seen far out at sea) that remained in the vicinity of the ship throughout most of the stay. The gulls would loaf on the surface of the water among the loose flocks of albatross. On occasion, albatrosses would rush at a gull if it came too close; the gulls, however, ate galley scraps along with the albatrosses. All three species would be so intent upon securing the scraps that they paid little attention to individuals or species. The large size of the albatrosses and their greater numbers, however, forced the gulls to the edges of the feeding area.

At another time a Pomarine Jaeger (*Stercorarius pomarinus*) remained around the ship for the greater part of the day. Albatrosses made no noticeable attempts to attack this bird, yet tolerated its presence only within certain limits; as soon as the jaeger drifted within the 'area of non-tolerance,' the albatross would make an apparently half-hearted attempt to drive the bird from its presence.

Usually Sooty Shearwaters (*Puffinus griseus*) were not seen on the stations except during cyclonic storms when winds were strong and seas rough. Under these conditions both albatrosses and the shearwaters were usually swinging over the ocean swells. When the shearwaters did alight they usually alighted singly and then for only a short time. Once I saw a single shearwater with a raft of albatrosses sitting on the ocean on a calm day. There was no noticeable antagonism.

Fork-tailed Petrels (*Oceanodroma furcata*) and Leach's Petrels (*Oceanodroma leucorhoa*) were seen quite frequently fluttering over the ocean as they fed on plankton or other sea life. No attention was paid by albatrosses or petrels to each other as far as I could determine.

At Area 4 on a dark, rainy, calm morning, a flock of 100 (+ or −) Pintails (*Anas acuta*) decoyed in to a raft of resting albatrosses which were one-fourth of a mile from the ship. During the course of the day, on several occasions I noted Pintails alighting with groups of albatrosses. As was the case with the gulls, the albatrosses would tolerate the ducks at a certain distance, only, and would chase them if they came within the elastic bounds of 'non-tolerance.' Some albatrosses were seemingly more belligerent or 'non-tolerant' than others. A shot by one of our gunner's mates broke a Pintail's wing. Attempts to retrieve the bird at the time failed. Albatrosses were attracted by the duck and followed the bird a mile or more as it swam and drifted from the ship. 'Gooneys,' it appeared to me, attempted to peck it more in curiosity than in a desire to destroy the bird (an hour later, the Pintail drifted back alongside the ship and was collected; it is now in the Museum of Vertebrate Zoology, Berkeley, California).

Albatrosses and Other Sea Animals

Sharks were not uncommon at any of the stations. The crew regularly caught them with baited hooks and lines. Oftentimes a shark swam near the surface with its dorsal fin protruding above the water level. Usually this attracted several seemingly curious 'Gooneys.' They showed no fear and I saw no attempts of the shark to attack them.

On several occasions I have noted a small group of 'Gooneys' (four to eight) massed about a floating sunfish (*Mola mola*). They usually were pecking the surface of the fish. I have often thought that the fish may have benefited by reduction of its external parasites in this manner. I have no definite observation, however, that the 'Gooneys' were actually eating parasites from the fish. Miller (Condor, 42: 229–238, 1940) also observed this.

I saw seals, porpoises, dolphins and whales on occasions, but I saw no associations between these animals and the albatrosses.

Enemies at Sea

Of all animal life, man is probably the greatest enemy to the Black-footed Albatross. At no time have I seen bird, fish or mammal (man excepted) destroy or attempt to destroy the albatross. Parasites and diseases, however, may cause death. I have not seen a dead albatross at sea, but the possibilities of seeing one are slight. Among the large numbers that were noted day after day in the vicinity of the ship, none were seen that showed outward signs of sickness or disease.

Even man shows much respect for this bird. Sailors will not tolerate, generally speaking, the shooting of the albatross, either in

TEXT-FIGURE 2.—This sketch was made from the fantail of our ship on a calm evening (September, 1945) and shows how the Black-footed Albatrosses gathered in loose flocks away from the ship. The small flock in the middle background had collected about a floating box. Other individuals are gliding in towards the ship. The bird on the extreme left is taking off (note the running position). The three birds in the foreground illustrate the differences in coloration; one is nearly black, whereas the other two have considerable white around the head, and one has a white rump.

respect of his seaworthiness or because of the many superstitions associated with the bird. I suspect the latter indirectly bears more weight.

External parasites (members of the Mallophaga group) were collected from the 'Gooneys' that I had in hand. These parasites seemingly caused albatrosses considerable discomfort at times, for I frequently saw them scratch and peck their body extremities. During the summer months a part of this activity may have been caused, however, by the molt.

From my observations, I concluded that *Diomedea nigripes* lives a life relatively free from predators and other decimating factors while at sea. The situation may be somewhat to the contrary on the breeding and nesting grounds.

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NOTES ON SAIPAN BIRDS

BY KEN STOTT, JR.

THE following observations were recorded during a period extending from December 8, 1945, to January 1, 1946. Although the duration of my assignment on Saipan, in the Marianas Islands, was brief, the nature of my military duties enabled me to spend a greater part of my time there in the field. Almost every part of the island was visited with the exception of the northern section of the central range of hills which at that time was still occupied by Japanese soldiers who had thus far evaded attempts at capture.

The southern tip of Saipan lies at latitude 15° 06′ N. and longitude 145° 45′ E. The island is approximately 15 miles long and 4 miles wide with an area of 72 square miles. A central range of hills runs from north to south, beginning with an 832-foot peak near Marpi Point at the northern end of the island and continuing to rise until an altitude of 1554 feet is reached at the peak of an extinct volcano, Tapatchau. From that point southward, the gradual slope toward Point Nafutan on the southern tip is broken by only two peaks (479 feet and 924 feet, respectively). A coral reef parallels a greater part of the western shoreline which is fairly regular. On the eastern side of the island two short peninsulas, Point Kagman and Point Nafutan, jet out to form Magicienne Bay.

In climate and flora, Saipan offers some contrast to its sister island,

white around the head, and one has a white rump.

Guam, which lies 121 miles to the south. We had found Guam hot and sultry but Saipan proved to be only pleasantly warm during the day and definitely chilly at night.

The vast groves of coconut palms (*Cocos nucifera*) which form so characteristic an ingredient of Guam's flora are represented on Saipan by only a few unhealthy-looking specimens along the beaches of the southern part of the island. The she-oak or casuarina (*Casuarina equisetifolia*) is common in the Saipan lowlands while the screw-pine or pandan (*Pandanus*) and wild breadfruit (*Artocarpus altilis*) constitute the most abundant plants on the ridge of forest-covered hills. Many of the lower hillsides support a dense growth of sugar cane (*Saccharum officinarum*) which, due to neglect during the war years, has run rampant.

The only noteworthy body of water inland on Saipan is Lake Susupe which lies approximately a mile inland from the southwestern shore of the island. The lake is surrounded on all sides by dense reed-beds and marshes which permit approach to the water's edge at only a few scattered points. Occasional pools of little importance occur along the west-central shore of the island.

The birds which I observed on Saipan may be divided into three distinct groups: resident land birds, migratory shore birds, and sea birds. Circumstances rendered it impossible for me to collect specimens but it is hoped that the following observational notes will prove of some interest. The nomenclature employed here is that of Ernst Mayr's 'Birds of the Southwest Pacific' (1945) and Peters's "Check List of Birds of the World."

List of Species Observed

WHITE-TAILED TROPIC-BIRD (*Phaëthon lepturus*).—These pelagic birds were often seen flying about the outskirts of the island, particularly those areas where the shoreline is bordered by high, rocky cliffs. A group of seven birds was observed on December 18 flying over Kagman Point at a considerable height in a high wind which preceded a severe storm. They were common about the cliffs in the Marpi Point area where they could be seen as they flew to and from crevices in the cliffs.

REEF-HERON (*Demigretta s. sacra*).—This species was common in the marshlands surrounding Lake Susupe. The Lake Susupe colony consisted of about 150 idividuals. All of the birds observed in that area belonged to the white phase. A single specimen of the dark phase was observed on December 24 on the beach at the south end of Tanapag Harbor.

CHINESE LEAST BITTERN (*Ixobrychus sinensis bryani?*).—This species was encountered regularly throughout the wooded portions of the island. It was often to be seen perching in the crests of wild breadfruit trees.

MARIANAS MALLARD (*Anas oustaleti*).—Although this species is reputed to be nearing extinction, it was encountered on each of three visits to Lake Susupe. On one such occasion seven birds were seen at the same time. The species apparently prefers the winding channels which lead through the reed beds about the lake rather than the open water. They are not unduly shy and may be approached within a few feet before they take to flight.

FERAL FOWL (*Gallus gallus*).—A pair of these birds was observed early on the morning of December 17 in the forest near Kagman Point.

GALLINULE; MOORHEN (*Gallinula chloropus guami*).—This species proved to be abundant in the marshy areas surrounding Lake Susupe. Due to the height and density of the vegetation, the bird was not often seen but its characteristic calls were continually heard.

PACIFIC GOLDEN PLOVER (*Pluvialis dominica fulva*).—This was a common bird on the sandy washes about Lake Susupe, in open meadowlands, and cleared areas, even in well-inhabited areas such as open places in and around the town of Garapan.

WHIMBREL (*Numenius phaeopus variegatus*).—This curlew was fairly plentiful on Saipan throughout December. It was seen along beaches, on mud-flats, and on cleared lands such as baseball and football fields on military bases. It was often seen in the company of Pacific Golden Plovers (*Pluvalis dominica fulva*).

WANDERING TATTLER (*Heteroscelus incanus*).—A single individual was observed on the rocky shore of Agingan Point on December 15.

GULL (*Larus* sp.).—A single gull in immature plumage was observed at Lake Susupe on December 23 and on several subsequent occasions. It was a small gull with a gray mantle, a white head with a dark auricular spot, and dark primaries. The tail was white with a narrow brown terminal band. The feet and legs were reddish and the bill was brownish with a black tip.

Dr. Ernst Mayr and Mr. Hustace H. Poor have suggested that the bird was probably either the Black-backed Gull (*L. ridibundus*) or the Herring Gull (*L. argentatus vegae*).

FAIRY TERN (*Gygis alba*).—This lovely bird was abundant throughout the island. It was always to be seen fluttering gracefully above the forest, even in the highest part of the island. Small flocks were seen perching in breadfruit trees. Their bickering "flight conversations" were often heard.

NODDY TERN (*Anous* sp.).—On December 10 and on subsequent occasions, Noddies were observed flying about and resting on the high rock designated as Tsukimi Island (which lies only a few hundred feet from Saipan) and on the corresponding cliffs of the latter island. On December 19 a pair was seen flying off Kagman Point. Due to their small size, very dark coloration, and type of habitat, I believe these birds to have been White-capped Noddies (*Anous tenuirostris*).

MARIANAS FRUIT DOVE (*Ptilinopus roseicapillus*).—Although they were shy and difficult to discover as they perched motionless in the dense vegetation, these handsome little doves were found to be fairly numerous in the forests which border the northern shore of Magicienne Bay. Unlike the White-throated Ground Doves (*Gallicolumba xanthonura*), they were not easily flushed and usually sat quietly until they were certain of discovery, in which event they would disappear rapidly into the depths of the forest. Their coloring, though vivid, renders them difficult to discern against their background of tropical greenery.

PHILIPPINE TURTLE DOVE (*Streptopelia bitorquata dusumieri*).—Ubiquitous. Unlike birds of this species I have observed on Samar and Mindanao in the Philippines, these were easily approached and were similar in habit to domesticated doves. They were often seen in the fields as they fed on the ground in the company of Pacific Golden Plovers (*Pluvalis dominica fulva*).

WHITE-THROATED GROUND DOVE (*Gallicolumba x. xanthonura*).—This bird was found to be common on brush-covered hillsides and semi-wooded country. It was seen on the ground in papaya thickets and perched both in low shrubs and high trees. Individuals were always observed singly.

EDIBLE NEST SWIFTLET (*Collocalia inexpectata bartschi*).—These little swifts occurred in fair-sized concentrations about cliffs on all parts of the island. They were seen in greatest numbers during heavy rains.

WHITE-COLLARED KINGFISHER (*Halcyon chloris albicilla*).—This bird was observed singly or in pairs on wooded hillsides throughout the island. It was not encountered in the open lowlands. In behavior and call it closely resembled *H. c. collaris* of the Philippines. Both subspecies seem quite at home in inhabited areas, suffering no noticeable ill-effects from the proximity of mankind.

NIGHTINGALE REED WARBLER (*Acrocephalus l. luscinia*).—A pair of these birds was seen perched in a tree on the border of a stand of she-oaks near Lake Susupe on December 16. At our approach, they dived into the clump of trees and were not subsequently observed nor heard.

RUFOUS-FRONTED FANTAIL (*Rhipidura lepida saipanensis*).—These nervous little birds were numerous in forested areas and vine-draped crevices in the lava above Magicienne Bay. They were observed as they foraged for insects through the undergrowth and along vines or sallied forth to capture their prey on the wing.

MICRONESIAN STARLING (*Aplonis opacus guami*).—Although we had found this bird to be numerous everywhere on the island of Guam, it appeared to be common only locally on Saipan. It occurred in large flocks in the Marpi Point and Kagman Point areas but elsewhere was distributed somewhat sparingly.

GOLDEN HONEY-EATER (*Cleptornis marchei*).—We failed to discover this bird until several days after our arrival on Saipan although we had devoted considerable time to searching for it. Unlike the Cardinal Honey-eater (*Myzomela cardinalis*), it appears to be restricted to a single habitat, that of dense forest. A single pair was observed on December 22 in the forest on the north shore of Magicienne Bay, and on December 24 several pairs were observed in the same area.

CARDINAL HONEY-EATER (*Myzomela cardinalis saffordi*).—As it had been on Guam, this bird was found to be present in fair numbers on all parts of Saipan. While it occurred in the littoral *Casuarina* stands, in the trees and shrubs of cultivated areas, and in vegetation about habitations, it was most abundant in upland forested areas. It was observed either singly or in pairs. Its appealing song is much in evidence. Its call is a high piercing whistle.

BRIDLED WHITE-EYE (*Zosterops conspicillata saipani*).—A flock was observed in a sugar cane field west of Kagman Point on December 10. On December 16 they were found to be common in the *Casuarina* stands and semi-wooded hillsides east of Lake Susupe where they occurred in groups ranging from three to 20. In behavior they bring to mind the Bush-Tit (*Psaltriparus minimus*) for their infiltration manner of moving through the vegetation is quite similar. The white eye-ring of this subspecies is very prominent.

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THE REPRODUCTIVE CYCLE OF RING-NECKED PHEASANTS IN MONTANA

BY ROBERT W. HIATT AND HARVEY I. FISHER

INTRODUCTION

ALTHOUGH the Ring-necked Pheasant, *Phasianus colchicus torquatus*, has been the object of innumerable studies related to its management, comparatively few of these investigations have been concerned with reproductive activities and only two (appearing after the inception of this study) have dealt with the anatomical development of the gonads. The primary objectives of our study were (1) to investigate the gonadal cycle of both sexes in wild birds, and (2) to correlate anatomical data with data derived from field observations on breeding behavior during the same season birds were collected for autopsy. However, the timely appearance of the two studies made on pen-reared birds provided the framework for another major objective, (3) to compare the gonadal cycle of wild birds with that of pen-reared birds. A secondary objective, highly significant from the viewpoint of management, was to secure evidence substantiating or refuting the assumption that pheasants rear a second brood during a single breeding season.

REVIEW OF PREVIOUS STUDIES

Recently, Kirkpatrick (1944a), working over a one-year period in Indiana, performed a series of autopsies on 177 pen-reared Ring-necked Pheasants. He noted that increases in testicular weight began as early as February 16, when the males were 271 days of age. At this time motile sperm was found in the testes, epididymides, and vasa deferentia. Histological observations showed precocious spermatogenesis as early as August and September when the birds were 94 to 109 days of age. The testes attained maximum weight on April 20 at 334 days of age and thereafter followed the usual cycle for adults. In a later paper, Kirkpatrick and Andrews (1944) reported upon a histological examination of the testes of 72 birds of pen-reared stock. Four phases of testicular growth were described. During phase 1 (from time of hatching until the eighty-first day, August 7) the testes underwent a gradual increase in weight; only spermatogonia and a few primary spermatocytes were present. Phase 2, which began on the eighty-first and terminated on the one hundred forty-fourth day (October 15), was characterized by a rapid increase in weight; three of the 18 testes sectioned during this period contained spermatozoa. A period of involution and decreased gonadal weight during which

the seminiferous tubules contained only spermatogonia and a few primary spermatocytes accompanied the third phase, which extended from the one hundred forty-fourth to the two hundred fifty-sixth day (February 10). During the fourth phase, which extended from the two hundred fifty-sixth day to the end of the year (May 18), the testes attained mature size and full spermatogenesis.

Wight (McAtee, 1945) recognized seven phases in the sexual cycle of Ring-necked Pheasants in Michigan. These phases were erected mainly on observational data on the behavior of the birds through an annual cycle. The longest period, "interphase" from late summer until late January or early February, was characterized by solitary cocks whose testes were small and non-functional. Cocks sought hens during the "premating phase" which started as early as February 10; during this period the testes were undergoing rapid recrudescence. The "mating phase" signified by mating [formation of harems?], copulation, and establishment of territories, began about February 27 and merged into the "laying phase" as early as April 12. After this time nests were constructed, eggs were laid, and copulation continued. Copulation terminated at the onset of the "incubating phase," and males no longer associated with hens. The "brooding phase," during which the juveniles were attended by hens and not infrequently by cocks, began as early as April 23 in some years, but most often was initiated in early May. In late summer, "postnuptial phase," the cocks began to molt, testes regressed, and the cocks became solitary. Wight (*op. cit.*: 146) further asserts that both sexes ". . . do not become sexually mature at the same time, hence cocks vanquished by an opponent or slow in maturing become available for females maturing at a later date."

In the domestic fowl, Latimer (1924) recognized some similarity between the growth curve of testes from developing White Leghorn cockerels and the four-phase growth curve characteristic for mammalian testes. He observed (1) a period of slow growth up to 50 days of age; followed by (2) an increase in rate of growth from 50 to 80 days; then (3) a period of rapid or pubertal growth up to 210 days; and (4) a terminal plateau or period following sexual maturity. Hogue and Schnetzler (1937) reported that although wide individual discrepancies occurred, Barred Plymouth Rock males reached sexual maturity as early as 16 weeks of age; however, in pen matings a satisfactory level of fertility was not observed sooner than 26 weeks. During the first eight weeks of life the seminiferous tubules contained chiefly spermatogonia. Testis weight approximately doubled between the eighth and twelfth weeks and primary and secondary spermatocytes were observed.

A testis weight comparable to that of mature males was attained at 18 weeks of age, at which time fully-formed spermatozoa were present. Parker *et al* (1942) found that the development of the testes of White Leghorn and New Hampshire cockerels closely paralleled that found for Barred Plymouth Rock males except for the precocity shown by the latter breed. Mature testis size in White Leghorn and New Hampshire cockerels was attained at 24 and 30 weeks, respectively, but spermatozoa were present in some during the twelfth week. Fertility tests showed that no cockerels which developed spermatozoa at 12 weeks of age were successful in fertilizing hens, but by the twenty-fourth week fertility was general for both breeds.

Kirkpatrick (1944a) reported that his pen-reared pheasants began to lay on April 8, which is approximately two weeks earlier than the earliest date recorded for wild birds by Grinnell *et al* (1918) near San Bernardino, California. Nests have been reported as late as August (Bent, 1932; Grinnell *et al, op. cit.;* and McAtee, 1945). The latest recorded successful hatching date is September 24 (McAtee, 1945: 143). The clutch is incubated from 22 to 26 days.

The question of a second successful brood in one breeding season has been discussed by several investigators. Some confusion has existed because several workers have failed to distinguish clearly between a second successful brood and the phenomenon of renesting following the destruction or desertion of the initial nest. Grinnell (1918: 575) states: "In Oregon it is said that three broods are reared in a season." Beebe (1922: 123) says that the ring-neck in its native Asiatic range sometimes breeds twice, but he makes no similar assertion for the other ancestral line of our American hybrid, *Phasianus colchicus*. Leffingwell (1928: 13) states: ". . . I believe that two broods are often raised as I have found nests as late as August 10th." Wight (1930: 224) says, "Early nesting pheasants usually again build nests and rear a brood," but Leopold (*cf.* McAtee) believes that he refers to renesting, not a second brood, since Wight observed that the cock starts to molt and becomes solitary before the first brood leaves the hen. Attempts at renesting by Michigan pheasants were noted as late as September. Leffingwell (*op. cit.:* 19) states that the cock often leads the brood when the brood is six or seven weeks old which suggested to him that the females were either setting or raising another brood. Leopold (1937: 100) is extremely doubtful that pheasants habitually rear a second brood and believes that second broods are not sufficiently common to exert an effect upon the breeding potential of the species. He believes that the relatively small birds often found in the fall are from late renestings.

Behavior normally associated with the breeding season has been noted at other seasons in several species of gallinaceous birds. Juvenile male Ring-necked Pheasants were observed to crow and to engage in frequent sham battles during August and September (Leffingwell, 1928). Forbush (1927) reported that Ruffed Grouse (*Bonasa umbellus*) copulated in autumn, while Allen (1934) states that this species is known to drum at all seasons. In Wisconsin the Prairie Chicken (*Tympanuchus cupido americanus*) has been observed to boom occasionally in mid-October (Hamerstrom, 1939), and Scott (1942) reported that a few Sage Hens (*Centrocercus urophasianus*) in Wyoming strut sporadically during warm spells in the winter months. Kirkpatrick and Andrews (1944) suggest that gonadal activity outside the usual breeding season may be responsible for the behavior since both Ring-necked Pheasants and domestic fowls show a temporary acceleration in testicular development at approximately 12 weeks of age.

ACKNOWLEDGMENTS

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MATERIALS AND METHODS

Field observations and collections were made in the irrigated valleys of the Yellowstone and Big Horn rivers in the counties of the same names in the vicinity of Billings and Hardin, Montana. Two and often three investigators were in the field during the year beginning in May, 1943, and ending in May, 1944. Early morning roadside censuses which were made at frequent intervals throughout the year enabled the observers to gather data from thousands of pheasants. Several pheasants were collected each week by shooting; by the end of the year 528 birds (319 males and 209 females, juveniles and adults) had been autopsied. Each bird was weighed and the depth of the bursa was measured at autopsy. A glass rod 2 mm. in diameter and scaled in millimeters was used for measuring the depth of the bursa of Fabricius. The vent was opened and the tip of the scale inserted and gently pushed inward with a rotary motion to cause it to be

lubricated from the inner surface of the bursa. This technique is similar to that described by Kirkpatrick (1944b). When the tip reached the blind end of the bursa the scale was released to enable the tissues to resume their normal position. Readings to the nearest millimeter were taken where the edge of the bursa crossed the scale.

Dissections were made, the testes were removed and preserved in a 10 per cent solution of formalin, and the ovarian development was recorded as described on page 539. Later the testes were weighed, the smaller ones on a milligram torsion balance and the larger ones on a chainomatic analytical balance. Each testis was removed from the preservative and gently touched upon a blotter until no more fluid drained from the surface. To check the accuracy of the method, one testis was weighed, resubmersed, and again weighed, in 25 successive trials. The mean weight was 1.349 grams, the standard deviation was 0.0039 grams, and the mean deviation was 0.00328 grams. Since the mean deviation was approximately four-fifths of the standard deviation, a relationship which obtains with distributions near symmetry, our method of weighing was deemed sufficiently accurate.

The largest juvenile and adult testes obtained during each weekly period were selected for sectioning. These were sectioned at 10 microns and stained in iron hematoxylin. After examining and plotting the stages of spermatogenesis found in this first group of testes, a second group was selected from those testes taken at critical times during the annual cycle, *i. e.*, the period of onset of complete spermatogenesis in the spring, the period of involution during the summer, and the period of increased gonadal activity in the fall. A total of 96 testes was sectioned and studied histologically.

Juvenile and adult birds could be distinguished during the summer, fall, and early winter by the depth of the bursa. In all pheasants more than one year of age, the bursa had either disappeared or was less than 11 mm. in depth, while all birds hatched during the spring and summer had a bursa at least 11 mm. in depth until the following January. Thus our findings on bursal depths of wild birds, except for a few minor discrepancies, coincide well with those set forth by Linduska (1943) and Kirkpatrick (1944b) for pen-reared birds.

Our data are usually presented separately for birds without a bursa, birds with a bursa less than 11 mm. in depth, and birds with a bursa 11 mm. or more in depth. The age-weight charts for juvenile pheasants given by Leopold (1937) and by Kirkpatrick (1944a) were utilized to ascertain the approximate age of some of the immature birds reported upon in this study. Despite the inaccuracies involved in using such charts formulated from data secured from pen-reared birds, the error is probably less than if the ages were merely estimated.

RESULTS OF THIS STUDY

The influence of age and season on testis weight for birds with a bursa at least 11 mm. in depth is summarized in Table 1. In these juvenile birds three growth phases were evident in the period from July to March. The first phase was characterized by a rather rapid increase in testis weight from July to September, with the mean testis weight doubling during each month. During this period the standard errors of the monthly means were very low and the coefficients of variation were large. The large coefficients of variation indicate the great individual variation in development which accompanies the rapid change in weight. The second phase extended from October through January during which time the monthly means of testis

TABLE 1

STATISTICAL SUMMARY OF THE GROWTH RATE OF RING-NECKED PHEASANT TESTES IN BIRDS WITH A BURSA AT LEAST 11 MILLIMETERS IN DEPTH

Month	*Number of testes examined*	*Range in weight (grams)*	*Mean weight (grams)*	*Standard error of the mean*	*Standard deviation*	*Coefficient of variation*	*Standard error of the coefficient of variation*
July	4	0.015–0.033	0.023	±0.004	±0.009	37.4	±13.21
August	26	0.010–0.104	0.041	±0.005	±0.026	63.7	± 8.84
September	26	0.024–0.267	0.088	±0.009	±0.048	54.0	± 7.48
October	42	0.038–0.125	0.082	±0.003	±0.019	23.3	± 2.51
November	20	0.045–0.098	0.066	±0.004	±0.018	27.9	± 4.41
December	8	0.046–0.101	0.065	±0.007	±0.019	29.4	± 7.35
January	17	0.045–0.130	0.079	±0.059	±0.025	31.0	± 5.31
February	11	0.026–0.295	0.146	±0.026	±0.087	59.6	±12.68
March	9	0.210–3.840	1.530	±0.419	±1.257	82.1	±19.33

weights were somewhat less than in the preceding period, and little change in weight occurred. In all young birds examined, the standard errors of the means continued low until January, but the coefficients of variation were smaller than in the initial growth phase, indicating less individual variation during this period of practically constant testis weight. Mean testis weight showed an upward trend in late January and was doubled in February when the third growth phase was initiated. An extremely rapid testicular development occurred in late February and early March, at which time the gonad reached the apex of its development for birds still distinguishable as immatures. Correspondingly high standard errors of the means and large coefficients of variation occurred in February and March,—demonstrating much variation between individuals in this time of greatest increase in testicular weight.

The influence of age and season on testis weights in birds with a

bursa either less than 11 mm. in depth or without a bursa is summarized in Table 2. Three growth phases were apparent during the annual cycle. The first phase began in mid-May, at which time mean testicular weights reached a maximum, and terminated about September 1, signifying the approximate end of involution. The standard errors of the mean gonadal weights were greater in this period than at any other time of the year, but within the period they were comparatively low from mid-May to June, increased during July, and were rather large in August. A comparable trend for the coefficients of variation was apparent, with the highest value in August. The relatively high standard error and coefficient of variation in August

TABLE 2

STATISTICAL SUMMARY OF THE GROWTH RATE OF RING-NECKED PHEASANT TESTES IN BIRDS WITH A BURSA LESS THAN 11 MILLIMETERS IN DEPTH OR WITHOUT A BURSA

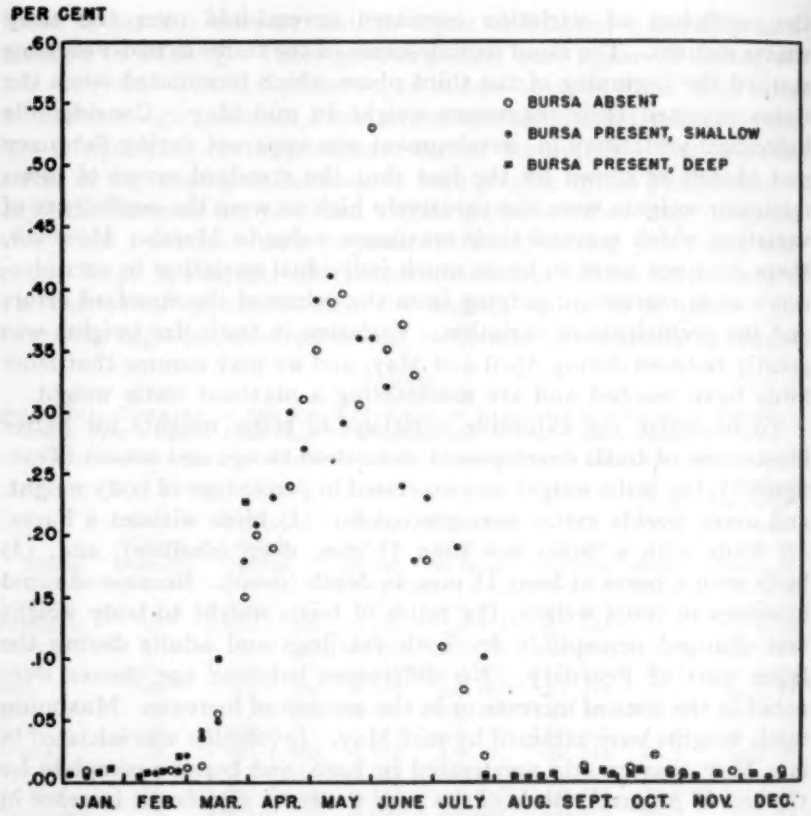
Month	*Number of testes examined*	*Range in weight (grams)*	*Mean weight (grams)*	*Standard error of the mean*	*Standard deviation*	*Coefficient of variation*	*Standard error of the coefficient of variation*
January	3	0.054–0.172	0.097	±0.038	±0.065	66.8	±27.25
February	23	0.056–0.420	0.176	±0.023	±0.108	61.6	± 9.09
March	47	0.193–3.746	1.334	±0.137	±0.943	70.6	± 7.28
April	45	1.539–5.449	3.259	±0.136	±0.911	27.9	± 2.94
May	60	2.314–7.556	4.564	±0.162	±1.253	27.5	± 2.51
June	45	1.711–8.093	3.587	±0.199	±1.338	37.3	± 3.93
July	16	0.726–2.914	1.633	±0.170	±0.681	41.7	± 7.37
August	8	0.183–1.562	0.788	±0.192	±0.543	68.9	±17.20
September	2	0.182–0.184	0.183	——	——	——	——
October	14	0.070–0.173	0.117	±0.010	±0.036	30.9	± 5.84
November	4	0.076–0.098	0.089	±0.005	±0.010	10.5	± 3.71
December	2	0.100–0.117	0.109	——	——	——	——

indicate a period of rapid change, and further show that involution of the testis does not occur simultaneously in all birds. The second growth phase which began early in September extended to mid-February. The minimal testis weights showed little change from October to February, and the interval was characterized by little or no activity in the regressed gonads. However, that recrudescence starts in February is demonstrated by the much higher maximal testis weight in this month. The standard errors of the mean testis weights are comparatively low except in January when the error was unusually high, perhaps due to statistical errors resulting from the small sample examined. By October most testes have regressed to approximately the same level and the coefficient of variation diminishes accordingly. During the latter part of this phase testicular activity started slowly and apparently differentially among the birds because

the coefficient of variation increased several-fold over the early winter months. The rapid recrudescence of the testes in mid-February marked the beginning of the third phase which terminated when the testes attained their maximum weight in mid-May. Considerable individual variability in development was apparent during February and March as shown by the fact that the standard errors of mean testicular weights were comparatively high as were the coefficients of variation which reached their maximum value in March. However, there does not seem to be as much individual variation in recrudescence as in regression, judging from the values of the standard errors and the coefficients of variation. Variation in testicular weights was greatly reduced during April and May, and we may assume that most birds have reached and are maintaining a maximal testis weight.

To minimize the extensive variation in testis weights for better illustration of testis development in relation to age and season (Text-figure 1), the testis weight was expressed in percentage of body weight, and mean weekly ratios were plotted for: (1) birds without a bursa; (2) birds with a bursa less than 11 mm. deep (shallow); and, (3) birds with a bursa at least 11 mm. in depth (deep). Because of rapid increases in testis weight, the ratios of testis weight to body weight first changed perceptibly for both yearlings and adults during the latter part of February. No differences between age classes were noted in the time of increase or in the amount of increase. Maximum testis weights were attained by mid-May. Involution was initiated in late May, was greatly accelerated in June, and became complete by the end of August. Birds of the year showed a significant increase in testis weight in September and October, after which time full regression ensued. The gonads of all males remained small from November until early February.

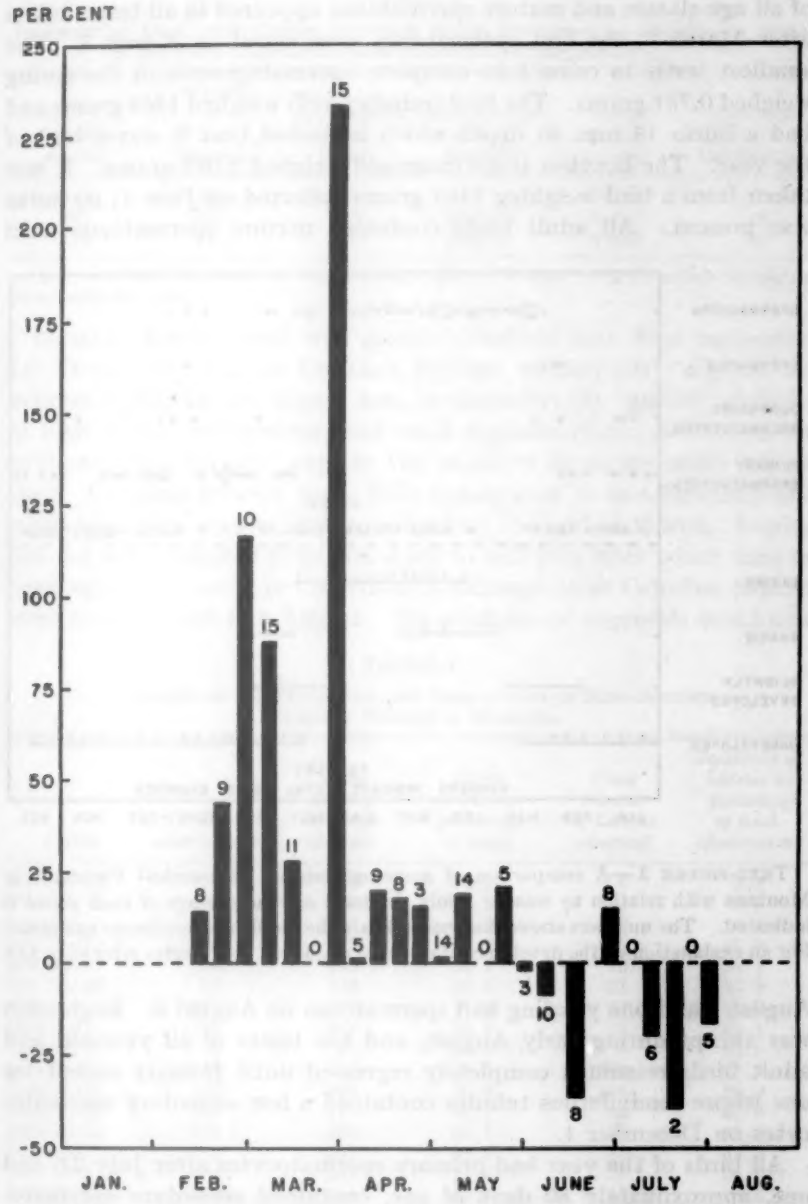
The rate of recrudescence in the spring for testes of all age classes was analyzed critically by ascertaining mean weekly weights and computing the percentage of increase in weight over the mean weight for the previous week (Text-figure 2). Because no significant change in weight occurred through January and the first week in February, the mean weight of testes examined during this period was selected as the initial weight. Rapid increases in weight occurred for the first three weeks or to about March 1 after which the rate of growth diminished until mid-March. The greatest weight increment occurred in the two-week period between mid-March and April 1 in which time the testes more than tripled their weight. After this date the rate of increment was much less but remained steady until the latter part of May. Reduction in weight began in late May and early June and



TEXT-FIGURE 1.—Testes weights of Ring-necked Pheasants in relation to season in Montana. Weights are expressed in percentage of body weight.

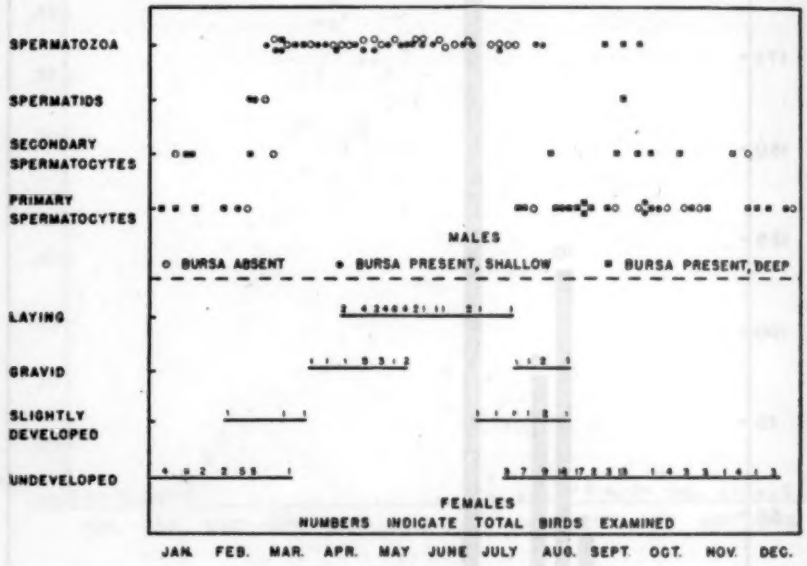
continued through July at a slow rate except for a brief period in late June and early July when, inexplicably, a slight increment in weight occurred.

The data derived from the histological study of spermatogenesis and the gross anatomical survey of oogenesis are presented schematically for comparison in Text-figure 3. Spermatogenesis is closely associated with the three growth phases mentioned for young birds (Table 1) and with the three growth phases indicated for older birds (Table 2). Spermatogonia and primary spermatocytes were present during all months of the year. Spermatogenesis was initiated in January when birds of all age classes developed secondary spermatocytes. By the latter part of February spermatids were present in birds



TEXT-FIGURE 2.—The average weekly rate of change in weight in testes of breeding Ring-necked Pheasants in Montana. The bars indicate the change in weight expressed as percentage of the average weight for the previous week. The number of testes weighed during each period is inserted at the end of the bar.

of all age classes and mature spermatozoa appeared in all testes taken after March 8; the first spermatozoa were noted on March 3. The smallest testis to come into complete spermatogenesis in the spring weighed 0.781 grams. The bird (number 449) weighed 1368 grams and had a bursa 14 mm. in depth which indicated that it was a bird of the year. The heaviest testis examined weighed 8.093 grams. It was taken from a bird weighing 1462 grams collected on June 1; no bursa was present. All adult birds contained mature spermatozoa until



TEXT-FIGURE 3.—A comparison of gametogenesis in Ring-necked Pheasants in Montana with relation to season. Only the most advanced stage of each gonad is indicated. The numbers above the lines indicate the number of specimens examined. For an explanation of the developmental stages employed for females refer to p. 539.

August 1 and one yearling had spermatozoa on August 6. Regression was abrupt during early August, and the testes of all year-old and adult birds remained completely regressed until January except for one whose seminiferous tubules contained a few secondary spermatocytes on December 1.

All birds of the year had primary spermatocytes after July 22, and one, approximately 80 days of age, contained secondary spermatocytes on August 11. All juvenile birds examined from September 15 to October 7 contained testes in an advanced stage of spermatogenesis and three contained mature spermatozoa during September. Pertinent descriptive data for these three birds are set forth in Table 3.

TABLE 3

DESCRIPTIVE DATA FOR THREE JUVENILE MALE RING-NECKED PHEASANTS WHICH UNDERWENT COMPLETE SPERMATOGENESIS IN SEPTEMBER

Collection number	*Weight of bird (grams)*	*Approximate age (days)*	*Approximate date of hatching*	*Testis weight (grams)*	*Depth of bursa (millimeters)*
259	1456	?[1]	?	0.125	22
291	1275	135	May 20	0.267	28
298	807	80	July 12	0.049	24

[1] Determination of ages from age-weight curves is impractical when young birds reach the approximate weight of adults.

Ovarian development was grossly classified into four categories: (1) "undeveloped," no Graafian follicles visible; (2) "slightly developed," follicles less than 5 mm. in diameter; (3) "gravid," follicles at least 5 mm. in diameter, and small eggs sometimes present in the oviducts; (4) "laying," eggs in the oviducts large, generally with a shell. Graafian follicles made their appearance in mid-February and small eggs were present in the oviduct by the end of March. Laying females were collected from mid-April to mid-July after which time no large eggs were noted in the oviducts although large Graafian follicles were present until late August. No evidence of oogenesis was found

TABLE 4

SUMMARY OF THE FORMATION AND DISSOLUTION OF RING-NECKED PHEASANT HAREMS IN MONTANA

Period	*Number of observations*	*Total number of birds observed*	*Birds in harems (percentage of total)*	*Total number of harems observed*	*Incidence of harems in percentage of total observations*
Mar. 16–23	129	888	0.0	0	0.0
Mar. 24–31	142	677	5.8	5	3.5
Apr. 1–7	33	112	15.2	2	6.1
Apr. 8–15	32	99	29.2	7	21.8
Apr. 16–23	28	143	55.2	18	64.2
Apr. 24–30	57	123	66.7	25	43.8
May 1–7	123	297	74.4	63	51.2
May 8–15	126	349	79.1	77	61.1
May 16–31	10	21	80.9	6	60.0
June 1–7	276	558	67.2	118	42.8
June 8–15	177	385	70.9	88	50.0
June 16–23	161	315	58.7	66	41.0
June 24–30	150	288	63.1	63	42.0
July 1–7	125	261	39.8	39	31.2
July 8–15	124	303	22.4	27	21.7
July 16–23	89	264	15.5	15	16.8
July 24–31	86	263	4.9	7	8.1
Aug. 1–7	110	416	2.9	5	4.5
Aug. 8–15	89	403	0.5	1	1.1
Aug. 16–23	80	436	0.0	0	0.0

in any juvenal females. All ovaries remained quiescent from late August to mid-February.

Behavior associated with gonadal development was analyzed through field observations. A summary of the formation and dissolution of harems of Ring-necked Pheasants during the study period is presented in Table 4. More harems were found in May than in any other month. At this time about 80 per cent of all the birds were associated in harems and three-fifths of all observations were those of birds in harems. By mid-August the cocks were either solitary or attending broods, and most of the hens were attending broods.

The first nest observed (April 15) contained an incomplete clutch

TABLE 5

SUMMARY OF FIELD OBSERVATIONS ON BROODS AND YOUNG OF RING-NECKED PHEASANTS IN MONTANA

Period	*Number of observations*	*Total number of birds observed*	*Number of broods observed*	*Total number of young observed*	*Average brood size*	*Young in population (percentage of total)*
June 1–15	11	682	1	5	5.0	0.7
June 16–30	19	550	6	15	2.5	2.7
July 1–15	19	491	23	119	5.2	24.2
July 16–31	17	459	57	260	4.6	56.6
Aug. 1–15	15	832	116	630	5.4	75.7
Aug. 16–31	17	1014	150	844	5.6	83.2
Sept. 1–15	8	402	67	279	4.2	69.4
Sept. 16–30	8	635	72	370	5.1	58.2
Oct. 1–15	12	1112	20	124	6.2	11.1
Oct. 16–30	13	1237	1	1	1.0	0.0
Nov. 1–15	6	181	0	0	0.0	0.0

of eggs. The last nest still being covered was recorded on July 27. Further evidence on late nesting was obtained indirectly by computing from age-weight curves the approximate hatching dates of young collected during the late fall and early winter. On December 16 an immature female weighing 715 grams and having a bursal depth of 22 mm. was collected. This bird was approximately 95 days of age which would set the hatching date about September 13. Several others are presumed to have hatched during August, judging from similar evidence.

A summary of the observations made on the occurrence of broods is presented in Table 5. The first brood, with young about the size of a Meadowlark, was observed on June 5 which indicates that the hatching date was in late May. Hatching dates computed from weights of collected juveniles also indicated that the earliest hatching occurred in the latter part of May. During August more than three-fourths of

all birds observed were immature. The last observed brood of the year was found on October 22; the young appeared to approximate adult size and were attended by a hen. After this date it was impossible to distinguish individual broods.

Attendance to broods by adult pheasants is analyzed in Table 6. Several trends, to be more fully discussed later, may be observed in this table. From June to October there was a constant decrease in the percentage of broods attended by one or more hens. From July to October there was an increase in the percentage of broods attended by a cock only, and there was also a gradual increase in the percentage of broods with no attendant adults.

TABLE 6

ATTENDANCE TO BROODS BY ADULT RING-NECKED PHEASANTS IN MONTANA

Month	*Number of broods observed*	*Percentage of broods attended by one hen*	*Percentage of broods attended by more than one hen*	*Percentage of broods attended by both cocks and hens*	*Percentage of broods attended by a cock only*	*Percentage of broods unattended*
June	7	86	0.0	0.0	0.0	14
July	80	56	11	13	1	19
August	266	56	4	8	3	29
September	139	34	0.0	9	22	35
October	21	43	0.0	9	24	24

DISCUSSION

The anatomical data presented in this study on wild male Ring-necked Pheasants are closely comparable to the findings of Kirkpatrick (1944a) and Kirkpatrick and Andrews (1944) for pen-reared birds. Since the present paper deals with a wild population, it was obligatory that immature birds be dissociated from adults. Consequently, only data for immature birds can be used for comparison with previous studies; heretofore, no investigation of sexual rhythms in adults has been undertaken.

Kirkpatrick and Andrews (*op. cit.*) find two phases of testicular growth from June to October, the first of which they state is characterized by a very gradual increase in testis weight, terminating about the first week in August. The second phase is termed one of rapid increase in testis weight. Actually, their figures show a weight increment of almost 6000 per cent and 225 per cent for the two phases, respectively. It would seem that the terms "very gradual increase" and "rapid increase" should be exchanged. Our data show the growth to be rather rapid and constant from July to late September; consequently, our first growth phase coincides with the first two growth

phases of the above workers. Our phases 2 and 3 correspond very closely to their phases 3 and 4. Three growth phases are adequate to describe the gonadal activity of adult male birds. Only the third phase coincides in all age classes, and no off-season development such as is characteristic of juvenile birds in September occurs in the older pheasants. Since individual variation in testicular development is greatest from January through March, and since this variation diminishes greatly during the mid-breeding season months from April to July, it is apparent that the rapid development of the testes in early spring is not simultaneous for all males, but that all birds reach approximately the same level of testis weight in April and early May. Similarly, the increasing variation in mean testis weights from June through August indicates that a differential involution occurs.

Spermatogenesis in our wild birds coincided almost exactly with that described by Kirkpatrick and Andrews for pen-reared stock. Moreover, considerable similarity in time was noted between spermatogenesis in juvenile pheasants and in juvenile domestic fowls. In both species increased gonadal activity begins between the eighth and twelfth weeks with complete spermatogenesis occurring in some at the end of the twelfth week. Some individuals of both pen-reared and wild pheasants attained complete spermatogenesis at about 80 days of age. However, domestic fowls which developed spermatozoa at 12 weeks of age were shown to be infertile at that time, and it seems likely that these precocious pheasants are similarly infertile.

Kirkpatrick and Andrews suggest that a like period of off-season gonadal activity may occur in some native gallinaceous birds. This may explain the courtship behavior found at this time, but which is normally associated with the breeding season. The data secured from both pen-reared and wild pheasants provide good presumptive evidence for this hypothesis, but our data show that such off-seasonal gonadal activity is characteristic only for male birds of the year and does not occur in older birds. This would indicate that perhaps only young males participate in these extra-seasonal patterns of behavior.

As in pen-reared pheasants (Kirkpatrick, 1944b; Kirkpatrick and Andrews, 1944) and doves (Riddle, 1928), the bursae of our juvenile wild pheasants attained maximal depths at the period of spermatogenic activity in September, and involution of both the testis and the bursa began immediately afterward. The above workers also noted that the thymus behaved similarly to the bursa. Our data provide further circumstantial evidence that testicular activity of young pheasants is physiologically associated with the subsequent involution

of the bursa, and that the bursa may have an endocrine function, particularly in view of the experimental evidence secured by Kirkpatrick and Andrews who produced highly significant decreases in bursal depths in sexually immature pheasants by injecting testosterone proprionate into normal and castrated males, and stilbestrol into normal females.

Nesting in Montana begins in April, the month in which nesting is reportedly undertaken in other sections of the United States. The nesting season in Montana extends into mid-September, which closely approaches the time of the last successful nesting recorded in the literature.

Male birds preceded females by approximately one month in attaining complete gametogenesis in the spring. Since complete spermatogenesis was achieved in all males within a period of two weeks in late February and early March, and since the ovaries in all females reached laying condition in a period of two weeks in late March and April, there is little factual basis for the statement of Wight that cocks vanquished by an opponent or cocks slow in maturing become available for those females which are slower to mature. The period comparable to the "premating phase" of Wight was devoted by the males to seeking hens and establishing territories. By late March a few harems had been formed, and copulation began. Within a month over one-half of the birds were segregated into harems; at this time all birds were capable of reproduction. By June 1 the number of harems began to diminish and broods appeared. The ovaries of some hens were inactive by mid-July, and in most hens this stage was reached by August 1. Gonadal involution in males was likewise complete in August. They became either solitary or attended broods after this time. The maximum number of broods was reached by mid-August.

Although we have no direct observational data to demonstrate whether or not Ring-necked Pheasants in Montana raise more than one brood per season, sufficient facts are at hand to compute the possibility and the probability of such an occurrence. The days required for rearing a brood successfully, as ascertained by this study are:

Days	*Item*	*Calculation*
18	Laying	12 eggs at 1½ days per egg
2	Interval	
24	Incubation	22 to 26 days
80	Dependency of young	Period until half-grown
Total 124		

A hen starting her first clutch on April 15, the earliest date on which eggs were found and the theoretical date of first possible laying (*see* Text-figure 3), could therefore not rear that brood and be ready to start a second before 124 days had elapsed, or on August 16. A new nest started then would hatch about September 28 and the young would not be independent until December 16.

Our data provide considerable circumstantial evidence opposing the possibility of a second brood as outlined above. Since cocks with mature spermatozoa were not found in the population after the first week in August, impregnation of the female would necessarily have to occur on or before this time. No laying hens were found among birds autopsied after late July, but a small proportion had gravid ovaries through mid-August. Hens starting to lay a clutch on August 16 would have had to retain viable spermatozoa for a period of about 10 days. Whether or not such retention in pheasants is possible is unknown, but female domestic fowl retain spermatozoa which effect a high degree of fertility for 10 days to two weeks. A rapid decrement in fertility ensues two weeks after impregnation, with a small proportion of eggs fertilized for as long as one month. Although a second brood is possible under such circumstances, it is highly improbable that most hens would begin the first nest on April 15, which is the earliest possible date, or that they would follow the rigid schedule of time required for two broods. It has already been pointed out that the last nest observed was on July 27 but that by computing the hatching date from the weight of an immature bird, the last hatching could have occurred about September 13 (two weeks before a second brood could have been hatched), which probably means that this is an instance of renesting. Thus, no field or laboratory evidence we have supports actively the hypothesis of a second brood.

However, the discussion above is predicated on the assumption that the hen attends her brood for an average of 80 days, at which time the chicks are about half-grown. There remains the possibility that some hens desert the young short of 80 days while others may remain with the brood until the young approximate adult size. The hen's activity in this regard is of great importance in any consideration of second broods. The data presented in Table 6 indicate that in July and early August about one-fourth of the broods were unattended by hens, and in addition about one-tenth of the hens were traveling with a brood also attended by a cock. It is evident that one-fourth of the hens were unaccounted for during July and early August. It is conceivable, therefore, that as Leffingwell (1928) suggested, some of these missing hens and some of those associated with cocks in dual attendance on

broods might breed and rear another brood. It is interesting to note in this same table that attendance to broods by hens declines as the breeding season progresses while the attendance to broods by cocks increases. Thus there is a distinct possibility that second broods may be produced by that small group of hens which desert their broods in July and early August. However, the precipitous decline in gonadal activity in both sexes by the end of July, the sharp reduction in number of broods observed in early October, the virtual absence of broods after late October, and the disappearance of most of the harems after mid-July suggest that second broods are certainly infrequently produced if at all. In any event, it is extremely doubtful if two broods occur frequently enough in Montana to exert any appreciable effect on the breeding potential of the species. The assertion made by the informant to Grinnell *et al* (1918) that three broods are reared in a season in Oregon seems absurd, and the statement by Beebe (1922) that the Ring-necked Pheasant sometimes breeds twice in its native Asiatic range lacks factual supporting data.

Many, if not most, of the late nests are undoubtedly the result of renesting. Since both males and females are fertile by mid-April, it seems reasonable to expect that most females have completed their nesting by July 1. Nesting attempts after this date were probably made by hens whose initial nests were destroyed or abandoned before hatching.

SUMMARY

1. The present investigation was undertaken to study the gonadal cycle of both sexes of wild Ring-necked Pheasants, to correlate anatomical and histological data with those derived from field observations on breeding behavior, and to compare the gonadal cycles of wild and pen-reared birds. Circumstantial evidence bearing on the possibility of second broods was also sought.

2. Field observations and collections were made from May, 1943, to May, 1944, in the irrigated valleys of the Yellowstone and Big Horn rivers in the vicinity of Billings and Hardin, Montana. A total of 319 cocks and 209 hens, both juvenile and adult, were collected and autopsied throughout the year. Ninety-six testes of juveniles and adults were sectioned and studied histologically. Age classes were selected on the bases of body weight and depth of the bursa of Fabricius.

3. Three growth phases of the testis, closely correlated with spermatogenic activity, were apparent for sexually immature males. The first phase, from hatching until September, was characterized by a

rather rapid increase in testis weight, and by seminiferous tubules containing only spermatogonia and primary spermatocytes until August 11, when secondary spermatocytes appeared. During September, three of the testes of ten juvenile birds contained spermatozoa. The second phase, which extended from October through January, was characterized by slight gonadal involution and general dormancy until spermatogenesis was begun in late January. Extremely rapid testicular development took place at the beginning of the third phase which ran to early March, after which time the birds were no longer distinguishable as immatures and spermatogenesis coincided with that of the adults. Full spermatogenesis was attained by early March.

4. In adult birds, three growth phases of the testis were likewise apparent. The first phase began in mid-May when testis weights reached a maximum and the seminiferous tubules of all testes contained abundant sperm. The phase extended to September 1 when involution was complete; but no sperm was found after August 4. The second phase, which was the interval between September 1 and mid-February, was characterized by little or no activity in the regressed gonads. Spermatogonia and a few primary spermatocytes were present during this quiescent interval, but we found no off-season spermatogenic activity similar to that present in some precocious pheasants and domestic fowl. The rapid recrudescence of the testis in mid-February marked the beginning of the third phase which terminated in mid-May when the testes were at maximal weights. By the second week in March, all cocks were in breeding condition and remained so until about August 4.

5. No differential testicular recrudescence between the various age classes occurred in the spring. Although recrudescence was rapid, the rate was irregular. Rapid weight increments occurred until about March 1 after which the growth rate diminished for two weeks. The greatest increment in weight took place in the last half of March when the testes more than tripled their size. A slower rate of growth ensued until mid-May when involution began. The high rate of recrudescence in early spring was not simultaneous for all males, but all reached sexual maturity within a period of two weeks. A differential involution likewise occurred over a relatively brief period; it showed more variability than did recrudescence.

6. Spermatogenesis in wild birds coincided almost exactly with that described for pen-reared birds, and considerable similarity was noted in the testicular activity of juvenile pheasants and juvenile domestic fowls.

7. Graafian follicles were first observed in mid-February, and eggs were present in the oviducts by late March. Laying females were

first noted in mid-April. No laying females were found after mid-July, but small eggs were present in the oviducts until late August. Juvenile females do not undergo off-season gonadal development as do young males.

8. Harem formation was first noted in late March and reached a peak in May when about 80 per cent of all birds were associated in harems. By June 1, the number of harems began to decrease and broods appeared. A rapid dissolution of harems occurred after July 23, and no harems were present after August 10.

9. The extent and season of nesting in Montana is the same as in other sections of the United States. The first nest (clutch incomplete) was observed on April 15, and the last active nesting was recorded on July 27. By computing approximate hatching dates for juvenile birds collected during late fall and early winter, it was found that the latest time of hatching was probably mid-September.

10. The first brood, composed of small chicks, made its appearance on June 5, indicating that hatching occurred in late May. The frequency of broods attained a peak in late August when 83 per cent of all birds seen were juveniles in broods. No broods could be recognized after October 20.

11. About one-fourth of the broods in July and early August were unattended by hens; most of these broods were unattended by any adult, and the remainder of them were attended by the cock alone. Three-fifths of the broods were accompanied by hens and one-tenth were accompanied by both parents. Attendance of broods by hens declined as the breeding season progressed while the attendance of broods by cocks increased.

12. The probability of hens rearing a second successful brood was found to be remote but possible for those hens which deserted their broods in July and early August. The precipitous decline in gonadal activity for both sexes by the end of July, the sharp reduction in number of broods observed in early October, and the dissolution of harems after mid-July suggested that second broods were indeed rare in Montana and exerted no appreciable effect on the breeding potential of the species.

13. Nesting after July 1 is probably renesting.

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PLUMAGE CHANGES IN THE GOLDEN EAGLE

BY MALCOLM JOLLIE

Plates 18–22.

THE appearance of the note by Spofford (1946) entitled 'Observations on two Golden Eagles' has been the stimulus for the presentation of this material which will attempt to answer his questions and indicate points needing further study.

Spofford was struck by the difference in his two specimens and said: "Inasmuch as the two eagles examined were as unlike as would seem possible within the limits of variation based on age and sex, it seems worth-while to append a brief description of each." He then proceeded to describe typical juvenal and adult plumages of the Golden Eagle (with the exception of the white epaulettes of the latter).

This plumage variability has puzzled taxonomists more, perhaps, than that of any other species of bird and, although we now associate the juvenal and adult birds as members of the same species and know that the plumage of the species is highly variable with age and individual, there is still need for an analysis of these variations. Such an analysis has been impossible because of lack of information regarding the manner of molt.

This paper is but a preliminary report in which I will describe as fully as possible, with the materials at hand, the process of molting as it occurs in this species and the individual and age variations which have made the study of this form so difficult.

The historical aspects of this problem need be treated only superficially. From the earliest observations, differentiation of the young and adults as separate species has resulted in hopeless confusion which has continued down to the present time among primitive peoples (Schäfer, 1939—central and western Asia). Therefore, comments will be restricted to more recent and better informed sources.

The first notes of interest are to be credited to Temminck (1820). Although he kept two birds in captivity over a period of years and made general observations on the pattern changes from the juvenal to the adult plumages, he did not record the manner of molting.

The unique character of the molt in this species was suggested by MacGillivray (1836). "They begin to moult early in the season, and the change of plumage is always very gradual. In some species new feathers are observed at all seasons, as is the case more especially with the eagles, which in this respect resemble the grous[e] and some other birds."

Naumann (1820–1847) in his 'Naturgeschichte der Vögel Deutschlands' gave considerable space to the "two species" of this bird. His descriptions, being based upon this erroneous assumption, are thus of slight value, yet he had observed the incomplete nature of the molt. His statement is as follows: "Wie beim Steinadler und andern grossen Raubvögeln geht auch hier der Federwechsel so langsam von Statten, dass sich beim Erlegen mancher Individuen Federn von dreierlei Kleidern finden, wobei dann die ältesten zur Unkenntlichkeit abgebleicht, ihre Enden verstossen und abgerieben sind, die jüngsten dagegen bei noch vollständigem natürlichen Umfange eine sehr dunkel und glänzende Färbung haben, gewaltig gegen jene abstechen und das Gewand noch bunter machen. Eben wegen der langwierigen Mauser möchte ein durchweg frisch hervorgekommenes Gefieder, noch in seiner völligen Neuheit befindlich, schwerlich vorkommen, dagegen die meisten Individuen theilweis zweierlei Kleider tragen."

Naumann described three plumages for each "species": a juvenal, an immature (molted two to four times) and an adult (a plumage achieved at an age of six to ten years?), but gave no account of molting from one plumage to another.

Brewer (1854) wrote that: "In a wild state, three years are required to complete the clouded barring, the principal mark of the adults, and which, even after that period, increase in darkness of color. When kept in confinement, the change is generally longer in taking place; and I have seen it incomplete at six years. It commences by an extension of the bar at the end of the tail, and by additional cloudings on the white parts, which increase yearly until perfected." In spite of his knowledge of pattern change Brewer did not describe the type of molt.

Booth (1881–1887) figured birds in three plumages; a juvenal, an immature and an adult. He commented that in his opinion maturity is reached about the fifth or sixth year.

The ideas of Naumann were much amplified by Severtzov who also can be credited with much additional information. Although his work represents the high point in the confusion concerning this species, it also represents the peak of detailed analysis. According to Severtzov, as translated from the French (Menzbier, 1894: based upon a monograph on the eagles by Severtzov), "the young bird begins to molt at the age of 14–15 months, in June and July. This molt, at first very slow, lasts until September or October. It is arrested in winter and continues during the following summer. The second dress is nearly complete at the age of thirty months (at the end of the second summer of molting). The first molt is entirely achieved by the third year

(beginning of the third summer of molting), but then, nearly without interruption, the older feathers of the second dress begin to drop, replaced by those of the third dress which is completed by the fifth year. The fourth dress is completed by the seventh year, the fifth by the ninth year, etc. . . . The ages corresponding to the diverse dresses may be determined from the individuals in molt, which always carry feathers of 3 ages: fresh, the previous year, and of the year before that, recognizable by their color and wear . . ." Further along he clarified his views as to the time required for a complete molt. "The common plumage is composed always of fresh feathers, of those of the year before, and of the year before that, . . . the mixed remiges and rectrices are of two years; fresh and of the year before, . . ."

Heinroth (1898), in discussing the molt of large predators, said: ". . . bin ich nicht im stande, die Mauserungsweise auf ein Schema zurückzuführen, man findet oft starke Unsymmetrieen der beiden Flügel sowie Ungleichheiten bei Vögeln derselben Art." He diagrammed the wing of a specimen of *Aquila clanga* and let the matter drop.

The classical works of ornithology by Gadow (1893) and Stresemann (1934) assume a complete annual molt. This general opinion has become quite fixed and generally accepted among ornithologists. This concept, along with a general understanding of the progressive pattern changes in this species, is found in Oberholser (1906), Forbush (1927), Engelmann (1928), Bent (1937), and Witherby, *et al* (1939).

Bent (1937), taken as representative of this group, assumed that the molt may extend from March until October (Forbush, 1927) but presented an unconvincing account. "The juvenal plumage is worn for one year without change except by wear and fading. From that time on progressive changes take place through annual complete molts, toward maturity . . . The fully adult plumage is not complete until the bird is four years old or more." He pointed out the progressive decrease in the amount of basal white of the plumage with age.

Perhaps the most impossible account is that of Cameron (1908) who wrote that "according to my observations the male eagle began to molt on April 13, . . . he had renewed his plumage by May 1. The female molted two months later, in the middle of June, and had finished molting by June 26, . . ." Such a discussion of molting is ridiculous to anyone familiar with the ways of even the barnyard fowl yet Cameron is not to be castigated for error. Errors have been the rule in the discussion of the plumage of this species.

Miller (1941) came close to the facts when he commented that "In the eagles and larger hawks the replacement of secondaries is comparatively irregular, as also in the *Cathartidae*. Apparently it is not uncommon for individuals to fail to molt all the secondaries in a single year."

Among the eastern Europeans, knowledge of the work of Severtzov has apparently been retained and I note Kozlova (1932) spoke of specimens as in the third and fifth dress. Kleinschmidt (1934) points out: "Das abgebildete Stück hat Federn von drei Alterskleidern, bis auf die Schafte abgenutzte, schwächer abgenutzte und neue ganzrandige."

A somewhat individual view (similar to that of Hartert, 1914) is expressed by Stegmann (1937) who said that molting from the first plumage begins at the end of the second summer and continues practically without pause through the whole year (and thereafter). At the end of summer and during the autumn molting is heaviest, and during the winter the feathers are freshest. He described five plumages from juvenal to adult.

Spofford (1946) cast doubt upon the published accounts of molt of this species and cited Severtzov's (1888) account as most satisfactory in explaining the partial molt and feather age variation he observed in his specimen. He stressed the need for observations on the molt of this species rather than the acceptance of unsatisfactory accounts in the literature. He is to be commended for observing the partial annual molt of this species, although this plumage character is so obvious that I have often wondered how so many diligent workers have overlooked it. (Many have probably suspected it.)

The incomplete nature of molt in this species was first recorded (to my knowledge) by MacGillivray (1836) and Naumann (1820–1847). In spite of early recognition, this fact had been "lost" until the account of Spofford (1946). The age at which the adult plumage is achieved has been variously stated but has never been based upon exact observations of an individual or upon the study of plumage sequence from skins. It is a sad commentary on modern, yet quite unscientific, ornithological writings that the ignorance of the past concerning this bird is constantly being perpetuated.

Recently, two papers (Spofford, 1942; Stabler, 1942) on the molt of several predators have been published. Papers on the molt of various species of hawks should produce information concerning the phylogeny of the group as suggested by Miller (1941) and, therefore, detailed observations on all species are solicited.

I first encountered this problem much in the same manner as Spofford. In March, 1941, I received a live, immature Golden Eagle from Jack C. Miles, a taxidermist, of Denver, Colorado. The eagle, "Miss Goldie," had been caught in a trap in northeastern Colorado. It died within two weeks of receipt and an examination of the bird indicated something like aspergillosis or tuberculosis. This is incidental to the topic at hand, but in preservation of this bird I noted that the wings were about one-half molted, about six of the inner primaries and a scattering of secondaries in each wing. The two outer tail feathers had been replaced but the others were "typical" juvenal feathers. In this manner I was introduced to the problem but assumed that the advent of disease might have put a stop to the normal molt.

After I became interested in the Golden Eagle, visits to museums to examine skins of this species focused attention on the matter of plumage variations and molting. It became apparent at once that only juvenal birds possessed a uniform, easily identifiable, plumage and that after the beginning of the first molt the specimens possessed both fresh and worn feathers. No matter in what season a bird was taken, it presented this mottled pattern (greatly variable as to the extremes of contrast) of feathers of different ages and, among subadults, of different patterns.

Although the period during which feathers were being replaced might be determined by a thorough study of the skins, the extent of each molt seemed impossible to determine satisfactorily. Attempts to employ pattern changes from the juvenal to the adult were blocked by lack of information regarding the molt. I attempted to separate one generation from the other by indications of difference in age (fading and wear). The newest feathers with a fresh sheen were easily identified but older feathers blended into the very oldest. It would seem logical that some feathers would be subject to more wear and fading than others and it was apparent that the softer plumes, when fresh, lacked the luster of the harder feathers (especially true of inner secondaries and the median and lesser wing-coverts).

One problem was to determine how much a feather could fade and wear in one year. Fading and wearing are especially noticeable among the lesser coverts of the wing. Observations indicated that in one year a feather could be bleached to a corn color and heavily worn along its margins. Thus lesser coverts in some (unmolted) juvenal birds matched the badly worn coverts of adult birds. It was quite clear from this point on that the extremes might be differentiated but that the intermediates must remain hypothetical until a sequence or, at least, a general pattern of the molt were known. Thus, unlike Spofford

(following Severtzov), I was unable to separate three generations of feathers; I was hard pressed to identify the newest generation with certainty.

In this study of birdskins, difficulties were legion and successes slight. The birdskins refused to allow a 'peeping Tom' to ascertain which feathers had been replaced and which had not. From a skin, only approximations concerning the order of secondaries could be drawn. These difficulties, I do not doubt, account for the general ignorance of the molt in this species. The solution to the problem seemed to lie in the study of the living bird.

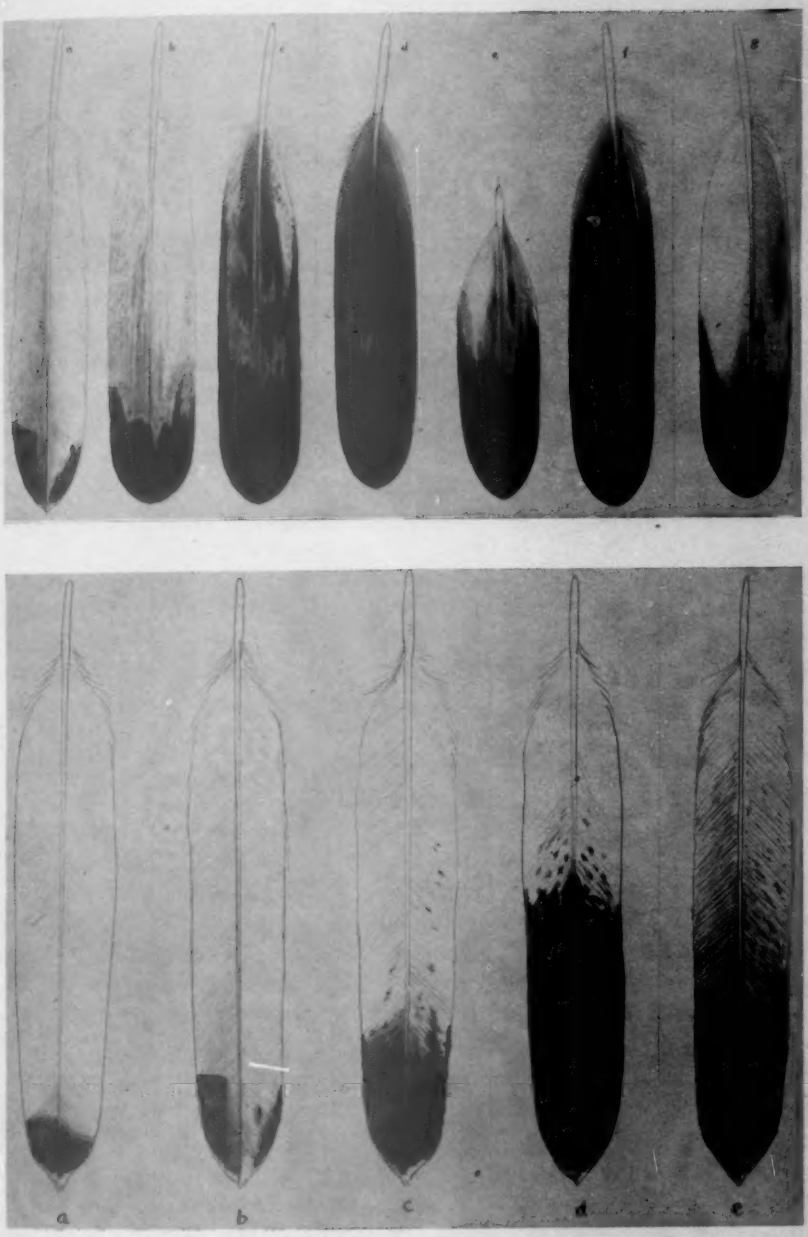
For more than four years I have concentrated my observations on this eagle and tried to make these observations as complete as possible concerning not only behavior but also individual variations and molting. Field observations have been secondary, however, to the observation of captive birds.

To date I have 'owned' six eagles at one time or another. Only three of these birds have contributed to my knowledge of the molt and pattern changes of this species, and frequent mention will be made of them through the remainder of the account. The most important character has been 'Smoky' 'the good egg.'

Smoky's story began on April 19, 1943, when Miss Verna Mace (Mrs. Don Zander) took two eggs from a nest in Larimer County, Colorado. The eggs were warmed in the sun and 12 hours after having been left by their parent they were placed in an incubator along with a miscellaneous group of eggs being prepared for embryological study. On April 27, Smoky hatched and her nest mate expired in the shell. From that time on she has been weighed, measured, and closely observed up to the time of writing.

The other birds were Apache and George. Apache was taken from a nest at the age of six and a half weeks by Richard Garrett near Boulder, Colorado, on June 6, 1942. This bird was held until January 23, 1943, when she was lost while flying near Boulder. George was taken from a nest in a eucalyptus tree on April 23, 1944, by Arthur MacAdams in Alameda County, California. This bird was held until May 15, 1945, when he was killed and preserved.

The method of procedure in studying the molt of Smoky was to collect all feathers that were dropped on each feeding trip up Strawberry Canyon (while studying at the University of California, Berkeley). Trips were made every two or three days although, on occasion, the periods were longer. The feathers collected on such a visit were strung together and stored. It should be indicated that my collecting technique during the second molt was much improved—every feather



GOLDEN EAGLE: (*Upper*) THE THREE CLASSES OF PATTERN ON RECTRICES AS PRODUCED BY SMOKY: a, b, c, d ARE FEATHERS PRODUCED BY LEFT-CENTER PAPILLA; e, f BY RIGHT-CENTER PAPILLA; g IS A SUBADULT FEATHER NEXT TO RIGHT CENTER (*see* TEXT-FIG. 6). (*Lower*) VARIATION AMONG JUVENAL RECTRICES (CENTRAL TAIL FEATHERS, LEFT SIDE).

large enough to see was saved. This paper is somewhat premature; I had not expected to work over the material until Smoky had molted into an adult plumage. However, I am confident that sufficient material is now at hand to treat this subject adequately.

During the course of this study specimens have been examined from several collections. References will be made to specimens from these collections by number and the initials of the museum. Collections examined are as follows: American Museum of Natural History (AM), notes taken by Charles Sibley; California Academy of Science (CAS); Chicago Natural History Museum (CM); Colorado Museum of Natural History (CMNH); University of Arizona—Department of Zoology Collection (UA); University of Colorado Museum (UCM); Stanford University Collection (SUC); and Museum of Vertebrate Zoology (MVZ) at the University of California.

At this point I would like to acknowledge the assistance I have received during the course of my studies of this species. I wish to thank the following for their efforts in my behalf: Mrs. Don Zander, Richard Garrett, Charles Sibley, Mrs. Jean Luce, Henry Weston, Arthur MacAdams, and Dr. Alden H. Miller.

No completely satisfactory description of the downs of the chick and their replacement has been presented but, as that is another topic, it must be reserved for another paper and only general remarks can be made here.

At hatching, the eaglet (weight about 100 grams) is thinly covered with a fluffy down (after drying) of light steel gray color with slightly darker tips. Seemingly, it is somewhat darker along the back, midline of wings, and especially the nape of the neck. The ear is rimmed with short, thick, conspicuously white down. Around the eye and on the edge of the eyelid the down is conspicuously dark. A few pink spots of skin are exposed along the vertebrae between the shoulders and also on the manus. The down on the ventral surface is incomplete medially, especially around the navel (umbilicus) and along the posterior aspect of the tarsus from the heel to toes. The down tracts of the chick are made up largely of prepennae with some 'preplumulae' in the apteria, especially posteriorly and ventrally.

At the age of six days the preplumule down has appeared everywhere. The teleoptiles are evident on the wings at eight days and all over the body somewhat later. The primaries were first detected at the age of eleven days, and at thirteen days they were about one-quarter inch in length. The covering of down improved as the preplumulae took over the function of covering the youngster. From about fifteen days on, this down was the prominent cover until over-

grown by the teleoptiles. The teleoptiles completely cover the down at about eight weeks and the young bird reaches full feather growth at the age of fifteen weeks.

At the age of eight weeks (approximately) the preplumulae begin to be molted (groin region) and are replaced by the plumules of the juvenal bird. This may be spoken of as the first true molt; finished by October of the year. The first molt of the teleoptiles and plumules of Smoky began at an age of about eleven months.

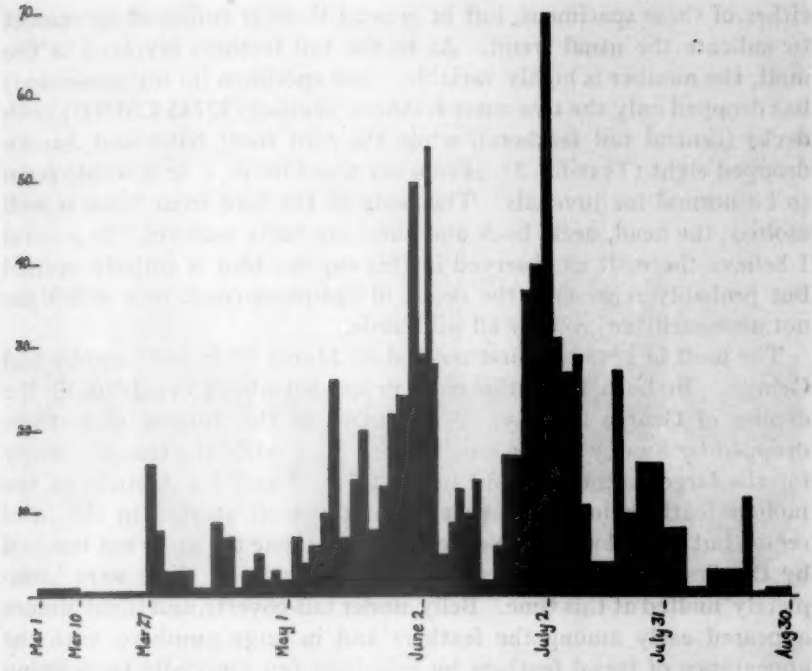
The complete molt of Smoky has been observed twice while only the beginning of the first molt was observed for George. In 1944, the first signs of molting were noted on March 11. A group of eight or ten feathers were growing in at the angle of the jaw on the left side. The molt was first substantiated by the dropping of down and feathers from the head and neck. At first the number of feathers dropped was small, gaining in numbers each week. By March 27 the first large wing-feather (primary No. 1 of the right wing) was dropped. Reference to Text-fig. 1 will indicate the number of feathers dropped each day throughout the molting period as averaged for the number of days in each collecting period.

A few notes describing this molt are in order. The first feathers to be dropped were from the nape area. On April 7 I noted the "head, neck, and chest fairly heavily molting. The head and neck are positively unsightly."

From the head and neck the molt progressed to the back and belly. The first under tail-covert was recovered on May 18. The plumage, from head to tail, from early in the molt period until its close, was "patchy." Although the anterior parts are the first to molt they continue molting to the last.

On June 3, I commented: "There is a large bare patch on the top of her head, but the head and neck are more than 50% molted. Her whole appearance is that of mid-molt and she is very patchy—light and dark. The angles of the wings and the underside are molting heavily and all the middle coverts of the wing are gone as well as patches here and there. Her back is heavily patched with new feathers and several large scapulars present the new color scheme, . . ." By July 13 the "upper part of the body appears 75% molted but 'patchiness' is not more or less marked than since starting her molt."

The completion of the molt was recorded on September 9. "Smoky appears to have completed her molt. I have not picked up any feathers for about the past two weeks." Further notes are recorded under September 16. "One tail feather and one flight (right wing No. 7) are still growing (three-quarters out). The body has become fairly



TEXT-FIGURE 1. Number of feathers molted each day during season of 1944 as averaged for each collecting period. Approximate total 1850.

solid in appearance but the partial character of the molt is obvious. Almost all the feathers of the neck, breast and back have molted but the belly and upper legs are patchy. Most of the lesser coverts of the wing are old ones and molting was heaviest at margin and angle." The under wing-coverts, tibiae and tarsi were untouched.

At this point it would be well to compare the results of this first molt with those recorded in the skins of museum specimens. For this purpose I have chosen a specimen in my own collection—a bird killed in the Chiricahua Mountains of southeastern Arizona. This bird was shot October 14, 1945, but, unfortunately, I could recover only the wings and feet, the rest having been burned. This bird was a typical immature finishing its first molt. The second specimen (62356 MVZ) was collected near Niles, Alameda County, California, and is dated October 20, ?. It appears to have finished molting.

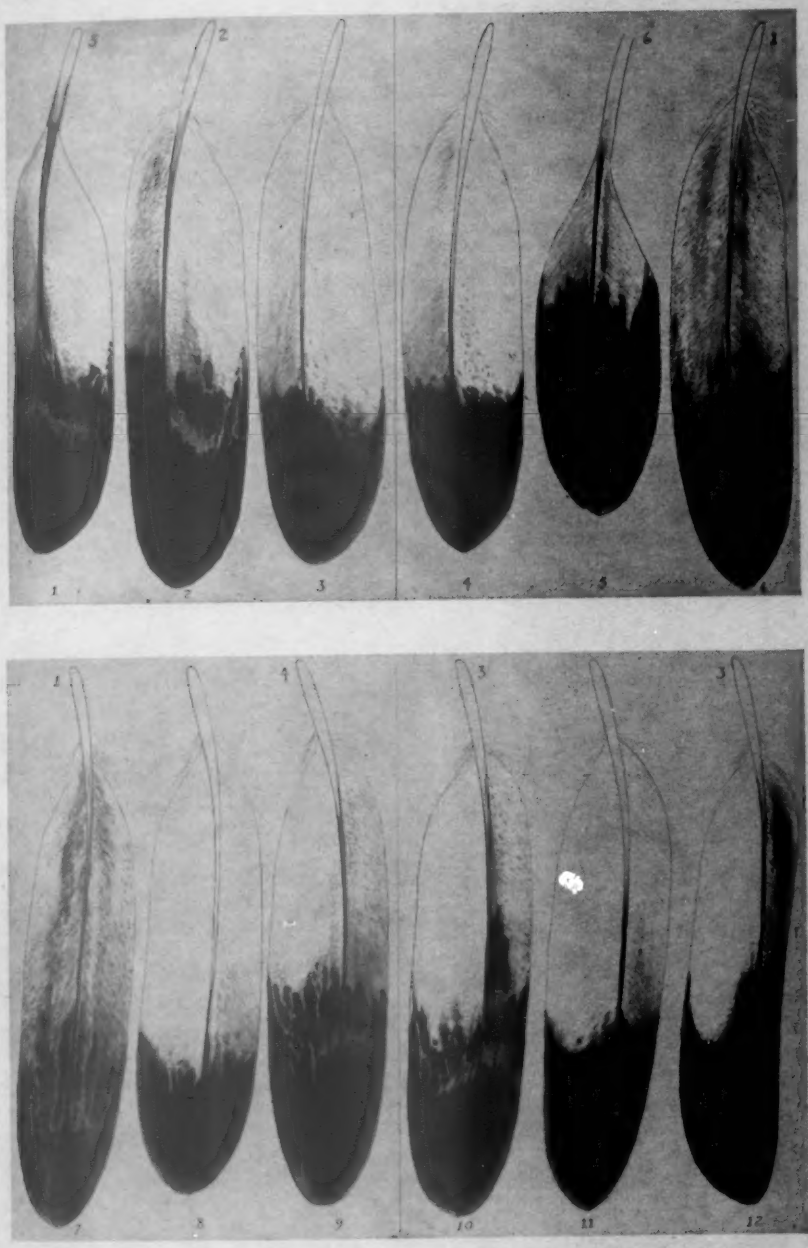
I have summarized the information regarding the wings of Smoky and these specimens in Text-figures 3, 4, and 5. It can be seen that the number of wing feathers molted by Smoky exceeds the number in

either of these specimens, but in general there is sufficient agreement to indicate the usual trend. As to the tail feathers involved in the molt, the number is highly variable. One specimen (in my possession) has dropped only the two outer feathers, another (22745 CMNH) both decks (central tail feathers), while the bird from Niles and Smoky dropped eight (Text-fig. 5). From my scant notes, 7 or 8 would seem to be normal for juvenals. The body of the bird from Niles is well molted; the head, neck, back and chest are fairly uniform. In general I believe the molt as observed in this captive bird is entirely normal but probably represents the result of optimum conditions which are not necessarily enjoyed by all wild birds.

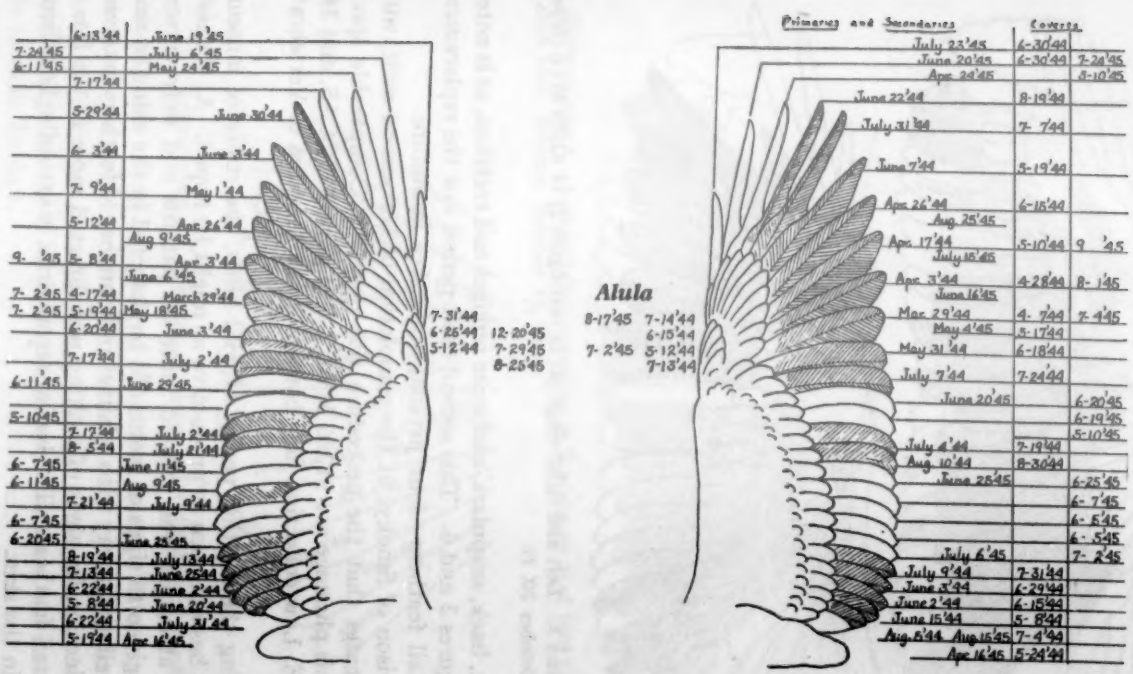
The molt in 1945 was first noticed on March 29 in both Smoky and George. In both birds the molt proceeded about evenly until the demise of George in May. A summary of the number of feathers dropped by Smoky can be seen in Text-fig. 6 while the complete story for the large feathers is told in Text-figs. 2 and 5. A study of the molted feathers indicated that again the molt started in the head region but shifted sooner to other areas. Among the areas not touched by the first molt were the under wing-coverts and these were 'completely' molted at this time. Belly, under tail-coverts, and tibial plumes appeared early among the feathers and in large numbers, with the appearance of tarsal feathers by mid-June (an especially large group on July 13). Meanwhile head, neck, back, breast and wing feathers were also dropped in quantity, up to the time of last collection on August 25. From information furnished by Henry Weston, the molt ceased about the end of the first week of September although, during the last of October and on December 20, two additional feathers were dropped. These last may have been due to accidents.

Unfortunately the difficulties of the material make it almost impossible for any complete statistical analysis, so I have dealt only in generalities. In my examination of Smoky at the completion of her second molt she presented a fairly uniform appearance and it would seem that most feathers have been molted at least once with a few old feathers at various points. The number of unmolted covert feathers in the wing is questionable, but some of the lesser coverts may have been skipped as the molt this season appears to be mainly marginal and next to the remiges. However, I doubt from their neat appearance whether many of them have been skipped. Rather I will assume that their normal color is lighter and more faded than the marginal feathers and larger coverts and such is the case.

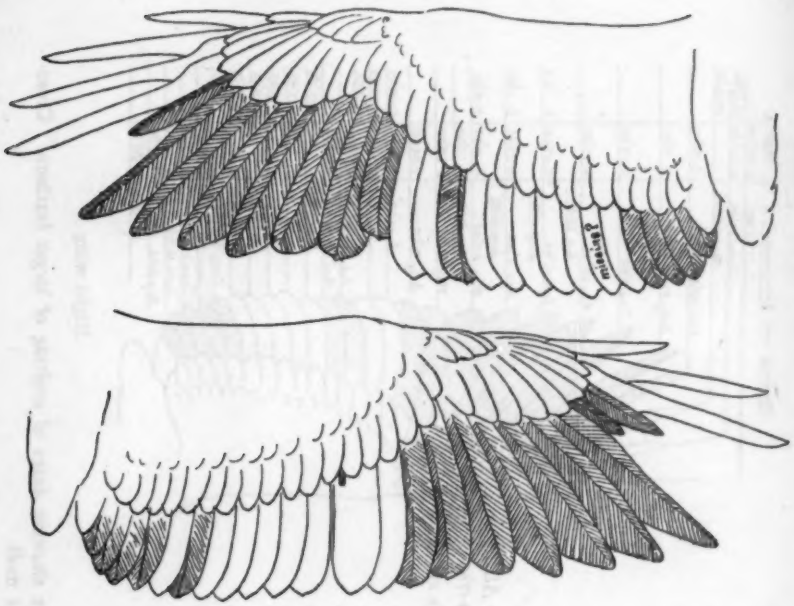
This molt can be summed up as completing that started the previous season with a simultaneous second molt for most (percentage?) of the



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF MVZ 62356—IMMATURE PLUMAGE. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.



TEXT-FIGURE 2. Wings of Smoky as viewed from above showing dates of molting of larger feathers. Cross-hatched primaries and secondaries were replaced during first molt.



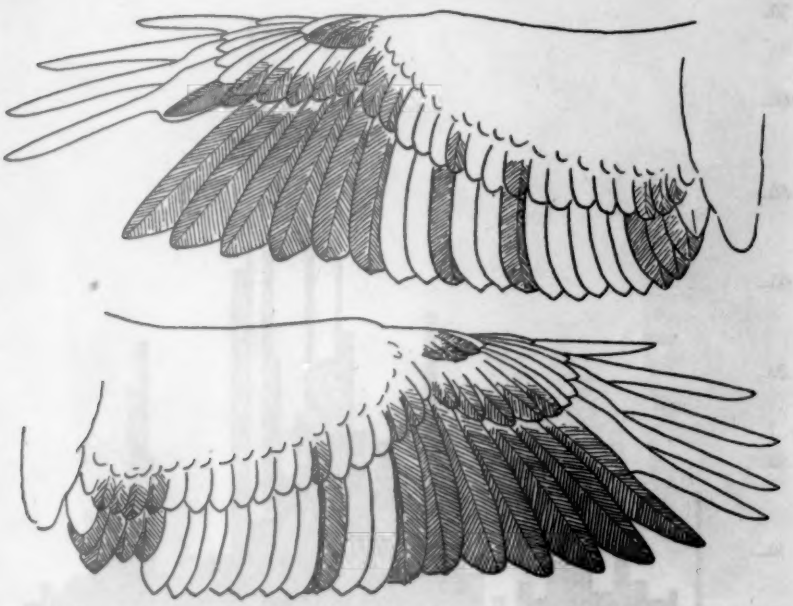
TEXT-FIGURE 3. Left and right wings (as in text-figure 2) of 62356 MVZ (Niles, California, October 20, ?).

head, neck, back, scapulars, and some remiges and rectrices, as is noted in Text-figures 3 and 6. This second molt period saw the replacement of seven tail feathers—four juvenal and three immature.

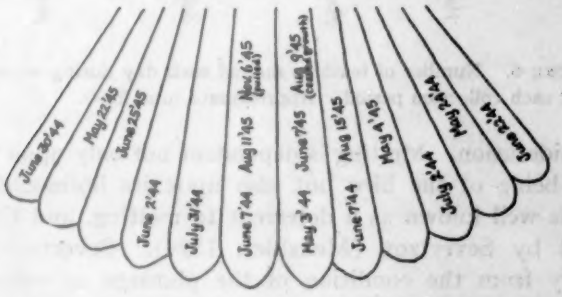
Comparison of Smoky, at the completion of her second molt, with skins indicates that the procedure was normal. Comparable specimens in this plumage are 91286 MVZ, 12511 and 18936 CAS, and 349 of the J. E. Law collection now housed at the Museum of Vertebrate Zoology.

Regarding the molting period of wild birds, the study of museum specimens has not been as productive as might be hoped. At the time of study, attention was focused more on pattern and only cursory attention given to signs of molt. To be detected in the skin the molt must be well under way with a fairly large number of feathers involved. My examination for signs of molting was directed more to the loss of wing and tail feathers. The loss of secondaries is exceedingly difficult to detect in the skin.

Of the 84 specimens examined personally, 23 were juvenals and showed no molt. Of the juvenals only seven were actively molting or had molted into a first immature stage. Of the remaining 61, 24 were taken during the period from November to February and showed no



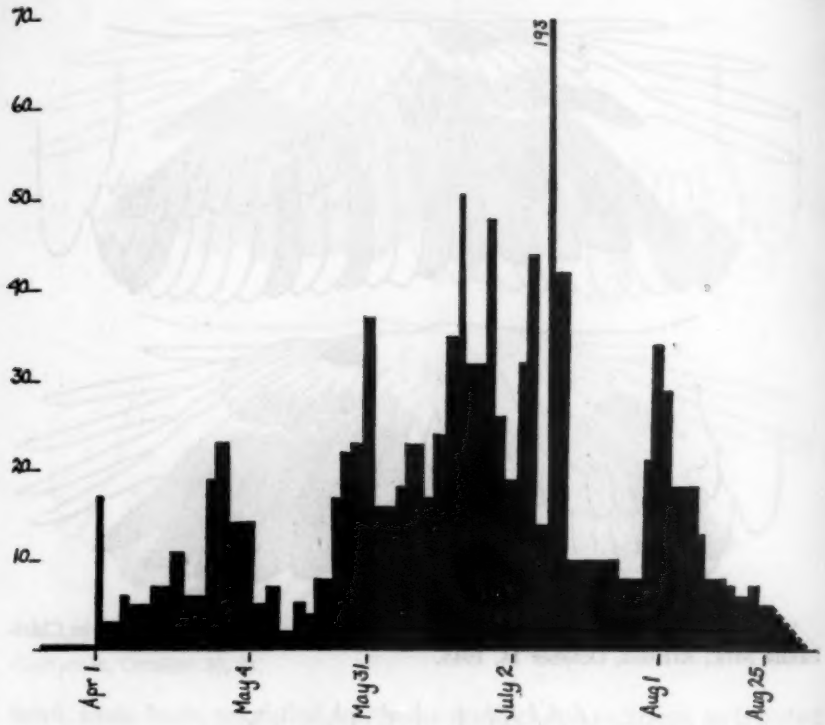
TEXT-FIGURE 4. Left and right wings (as in Text-figure 2) of bird taken in Chiricahua Mts., Arizona, October 14, 1945.



TEXT-FIGURE 5. Replacement dates of tail feathers of Smoky.

active molt except in several doubtful cases. Incomplete notes eliminate part of the remainder leaving only 21 specimens for which useful information is available. To this information I have added observations on three birds in the Denver zoo, and have summarized the facts in Table 1.

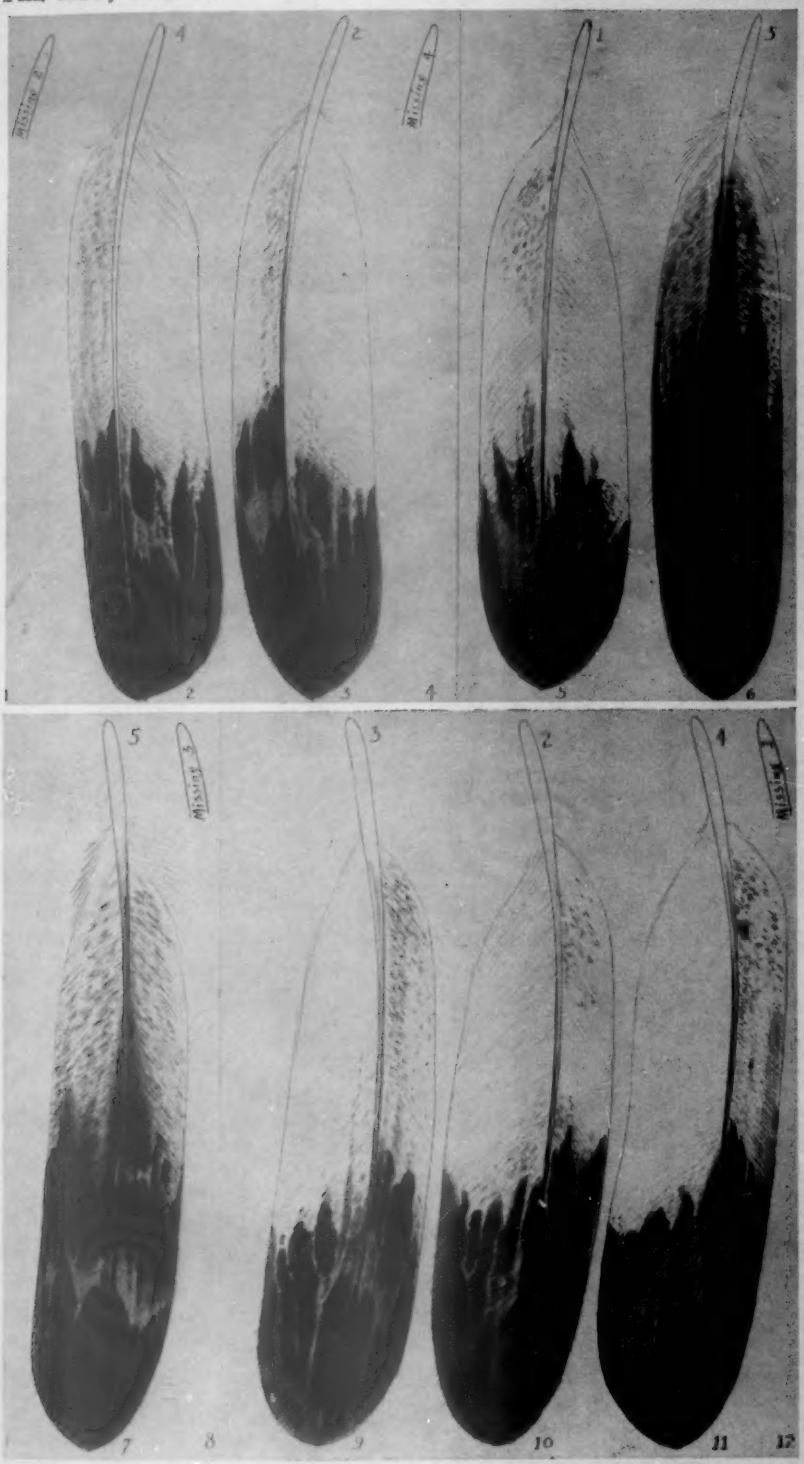
The molt of Smoky in captivity is corroborated by Table 1 and by observations in the field. It should be kept in mind that in the field only the more obvious losses can be detected. Most of my field observations have been made on adults and, therefore, certain facts must be



TEXT-FIGURE 6. Number of feathers molted each day during season of 1945 as averaged for each collection period. Approximate total 2600.

given consideration. Molting is dependent not only upon the physiologic well-being of the bird but also upon its hormonal condition. Breeding is well known as a deterrent to molting, and this fact was recognized by Severtzov (Menzbier, 1894). Severtzov concluded erroneously from the condition of the plumage as correlated with testicles in several specimens that the birds bred on alternate years, molting lightly during the breeding year and heavily during the year of rest. It is to be assumed from this that adults will commence somewhat later than immatures or non-breeding adults and perhaps continue molting somewhat later in the season (1568 UA; see Table 1).

From my field notes several exceptional instances can be cited of protracted molting through the winter months. For December 31, 1942, I have: "A second eagle appeared from Two-mile Canyon direction; came overhead, passed to the northwest and returned overhead low. Molting inner flight, fairly apparent (second or third in right wing)." On January 24, 1943, a pair was observed of which the female



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF BIRD FROM COLOMBIA, CALIFORNIA, ILLUSTRATING IMMATURE TYPE OF TAIL. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

TABLE I

Specimen	*Museum*	*Age*	*Date*	*Sex*	*Remarks*
JUVENAL TO IMMATURE:					
160281	CM	11 mo.	3/19	♀	Few new feathers in wing
160279	CM	11 mo.	3/26	♀	No sign
	Jollie	18 mo.	10/14	♀	Feathers of wing still growing
62356	MVZ	18 mo.	10/20	♂	Feathers of wing and tail growing
1722	UA	18 mo.	10/23	♂	Feathers of wing and tail growing
101185	CM	19 mo.	11/28	♀	Finished
91286	MVZ	20 mo.	12/20	♂	Finished
IMMATURE TO SUBADULT:					
	Jollie	22 mo.	2/29?	♀	No sign
12511	CAS	28 mo.	8/24	♂	Nearly finished. Wing and tail still growing
SUBADULT TO FIRST ADULT: FIRST ADULT TO ADULT:					
22436	CMNH	35 mo.	3/8	♀	Beginning; breast and belly?
	Denver Zoo	36 mo.	4/3	?	Started
	Denver Zoo	Ad.	4/3	?	Started
	Denver Zoo	Ad.	4/3	?	Started
349	Law (MVZ)	36 mo.	4/8	♀	Molting begun
7292	SUC	Ad.	4/19	♂	Not obvious
19075	CAS	39 mo.	7/11	♀	Molting heavily
12511	CAS	40 mo.	8/24	♂	Feathers of wing and tail growing
53801	MVZ	Ad.	"Fall"	♂	Molting heavily
53802	MVZ	Ad.	"Fall"	♀	Molting heavily
39146	CAS	Ad.	10/26	♂	Tail feathers still growing
1569	UA	Ad.	11/5	♂	Tail feathers still growing
12820	CAS	Ad.	11/13	♂	Finished
Black Mt.	SUC	Ad.	11/17	♀	Finished
562	Brooks (MVZ)	46 mo.	2/1	♂	One tail feather growing

showed a notch in the secondaries of the right wing and the tail was exceedingly irregular in outline as though several feathers were coming in. Another female observed on January 27, 1943, lacked the two first secondaries of one wing. During a relatively brief period of observation, the first two examples seemed gradually to achieve a more perfect appearance, especially the latter. It can not be stated definitely that these birds were undergoing molt but the evidence would suggest it. Although I have observed about 30 different pairs at all months of the year (observations made mainly in spring, early summer and fall) signs of molting were detected only in a few individuals.

On March 9, 1946, the female of a pair was noted to have a gap in the secondaries, at, or inside, the fifth secondary of the right wing. An adult bird observed on March 15, 1946, had two gaps in the tail, indicating recently molted feathers, and a first primary missing in the left wing. This bird, from the circumstances of the observations, may have been a non-breeding adult.

On April 9, 1944, I observed near his nest a male bird which appeared to be molting. My notes read, "the male has molted the sixth (?)

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primary in the left wing. The right wing is missing the first (?) primary and a secondary at the secondary center (fifth secondary) of molt." Three weeks later the wings seemed to be mended.

Secondaries have been found at nests during two seasons on June 6. In the latter case the male was observed at close range and was molting heavily. In contrast the female seemed immaculate.

A pair of eagles observed near Oakland were first noted to be molting on June 10, 1945 (several feathers recovered) although no sign of molt could be detected in wing or tail.

A juvenal eagle was observed on June 16, 1943, near Monarch Pass, Colorado. This bird lacked an inner primary and, perhaps, a secondary. The tail appeared to be complete.

A pair of eagles breeding east of Oakland showed gaps in the wings on July 2, 1944. "Both birds have apparently started molting. The female appears to have dropped both first primaries and the male may be missing a secondary. Obviously (?) not molting heavily yet." I recovered several contour feathers from the vicinity of the nest.

From my field observations I conclude that remiges or rectrices may be replaced at any season but, in general, conform to the molting season as described for Smoky and as shown for skins in Table 1.

The incomplete nature of the molt in the Golden Eagle which has led to the lengthy descriptions of Severtzov and the confusion of others seems to be a characteristic of the "Aquilid" group[1] (genera *Aquila*, *Hieraaëtus*, and *Uroaëtus*). Friedmann's (1930) account of *Aquila rapax* would suggest this and my own examination of adults of this species would confirm it. Heinroth (1898) commented on the irregularity of *Aquila clanga*. Whether a molt of this type occurs outside the group I cannot say. I would suspect that such a bird as a California Condor (see Miller, 1937) or any of the large Old-World vultures might need extra time. Examination of skins of the Condor reveal no indications of the molt. Severtzov (Menzbier, 1894) noted that the Lämmergeier has a complete molt of remiges and rectrices but said the body takes two seasons. The Bald Eagle, according to Crandall (1941), undergoes a complete annual molt, and examination of skins indicates that such is the case.

From a study of the molt both in captive and wild birds the following conclusions can be drawn.

1. A 'complete' change in plumage is achieved in two seasons. It would appear that, in general, the molt is incomplete the first season and is completed the second, along with a simultaneous remolting of some areas.

[1] Basis for designation of such a group not corresponding to any subfamily of the *Aquilidae* recognized at present will be presented in another paper.

2. There is a general anterior-posterior gradient of tract importance, beginning on the head and proceeding posteriorly to the other parts. The first molting period is characterized by near completion of the anterior dorsal areas while the posterior and ventral tracts are scarcely touched. During the second period these posterior and ventral tracts are replaced. The position of a tract in the gradient series shows correlation with its importance to the welfare of the bird. The primaries (and tail feathers?) are largely replaced each year while the less important secondaries are replaced much more slowly.
3. Each tract seems to have independent control, and more or less clearly attempts a complete annual molt. Success depends upon size, the overlooking of irregularities, and position in the gradient series. It would seem that the head, neck, back, throat, scapular tracts and alulae are largely replaced each year (along with the primaries and rectrices) while the under wing-coverts and the tarsi are molted only on alternate years.
4. Individual feathers at any point may be missed in the molt (especially in linear series) and are not picked up until the next round of molting. This is well shown by flight-feather 7 in Smoky's left wing. Irregularity increases with age; adults scarcely follow any pattern.
5. In linear series such as the remiges and rectrices there is some order to the molt. Order among the primaries is fairly rigid and proceeds from the inner one outward. Among the secondaries there is an inner, a median (at no. 5) and an outer molt center and replacement is fairly orderly but much more subject to irregularities than in the primaries. The greater coverts of the wing usually drop in the same order as the secondaries, while the median coverts drop irregularly and are largely replaced during alternate seasons. The tail feathers have lost all semblance to order and irregularities are the rule, although the molt seems to start most frequently with the central feathers.

Viewing the molt of this species in the light of what takes place in the Bald Eagle, there is no reason why a complete annual molt should not take place. Even when molting is heaviest the flight potential of the bird is but slightly reduced. A combination of extreme dependence on flight perfection and the time needed for the growth of new feathers must be tentatively accepted as the answer.

An appreciation of the changes in pattern that occur in the Golden Eagle will necessarily depend upon an understanding of both the individual variation that occurs in this species and of the mechanism that determines the age variations. As most authors have pointed out, the change in pattern, particularly of the rectrices, is one of increasing darkening and banding with the final elimination of the white bases of the juvenal feathers. As it is quite clear that the rectrices take longest to achieve an adult pattern, I will depend largely upon them in discussing these changes.

It should be made clear at once that I do not claim to offer a solution for the age identification of all specimens. However, I feel that most of the non-adult specimens can be identified with some surety. As I

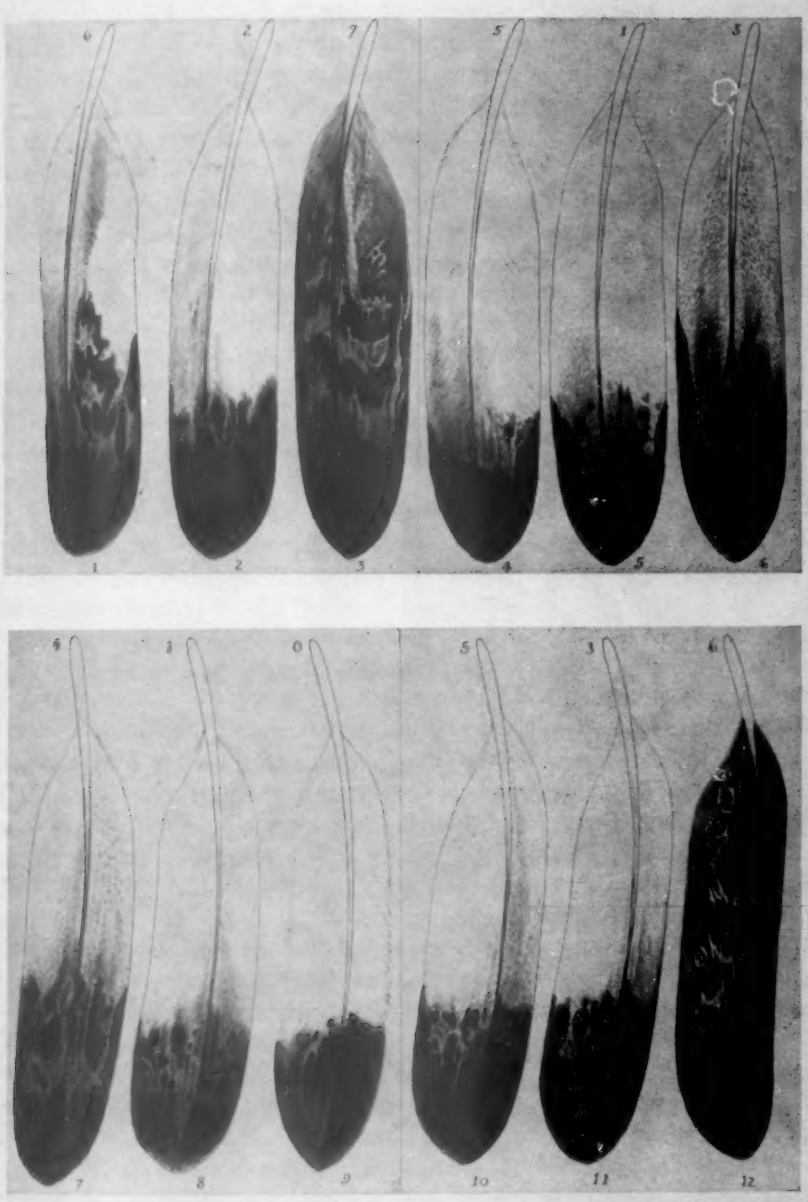
do not think a word description can possibly convey the images which I wish to offer, I have prepared a group of illustrations to go with the brief descriptions. In all, I recognize five age plumages of the Golden Eagle; a juvenal, immature, subadult, first adult, and adult.

The question of what determines the pattern of a feather presents a most interesting problem. In general, my remarks are all based upon a theory which has yet to be tested, although, it seems to me, a paper by Boss (1943) throws some light on this problem. Boss, studying Herring Gulls in which a pattern change somewhat similar to that in the Golden Eagle takes place, discovered that the adult plumage was determined by the presence in sufficient quantities of the male hormone.

As the gonads of both male and female gulls produce the male hormone, the development of the adult plumage was determined by a minimal level that was achieved in both sexes at three years of age without the appearance of sexual behavior. As breeding does not take place till after the assumption of the adult plumage, the males do not achieve this plumage earlier than the female. Other characteristics (bill color, etc.) would indicate that, as in adults, the gonads of the immature birds undergo seasonal periodic changes (most noticeable of course in the subadults). Thus there was superimposed on the gradual growth of the gonad, secondary seasonal changes in size or at least hormone productivity.

Some time prior to seeing this paper, I had expressed similar ideas concerning the cause of plumage changes in the Golden Eagle. These ideas were not well received on the grounds that no such case was known to exist. I attempted to secure pellets of male hormone in order to test its influence on the pattern of a young male (George) but unfortunately could obtain none. Although this is but a possibility it seems to me certain that some similar situation controls the pattern in this species.

Regarding the hawks in general, this theory finds little support. It has been noted by falconers that when a feather of a juvenile bird is pulled, either a juvenal or an adult feather (depending upon the date) replaces the lost plume. There are no instances of an intermediate type, but, as the smaller hawks, with which I am familiar, attain the adult plumage at the first molt, it seems probable that a juvenal type is produced until a threshold quantity of some hormone throws the switch to the adult type. In only one species, the Goshawk (Bond and Stabler, 1941), has there been any indication that pattern changes can be traced through a sub-adult stage achieved at the first molt. The subadult stage is only an average in the Goshawk, however, and does not constitute a really recognizable individual plumage.



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF MVZ 91286, ILLUSTRATING SUBADULT STAGE. UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

In the Golden Eagle, if the development of pattern is a gradual thing, not a step-like series, becoming increasingly darker with an increase in hormonal output of such an organ as the gonad, the pattern in a tail should indicate this. Unfortunately nothing is known about the seasonal gonadal changes in eagles, therefore no correlations are as yet possible.

In an effort to find out whether transitional types exist, I have pulled the tail feathers of two captives. On October 2, 1942, a juvenal central tail feather was pulled from Apache and was replaced by a feather of a weak immature pattern. A deck feather of a similar pattern is to be found on 22745 CMNH. This feather was closer to the normal second-plumage type than those produced by 80785 MVZ or feather 5 of Plate 20, upper figure.

On October 21, 1944, a juvenal central tail feather was pulled from George, and on February 3, 1945, another. The new feathers showed a transition toward an immature type.

I doubt that an eagle's rectrix follicle ever duplicates, in the broad sense, the same pattern; variations are always present. As a tail feather takes 75 days to grow, a considerable physiologic change can take place in that time.

From the evidence at hand I must reverse my former beliefs and say that there are transitional stages from the juvenal type toward the adult. No one will deny the extreme variations, almost continuous, that exist, but an understanding of them must be based upon a knowledge of the general transitional patterns of plumage changes that take place as the juvenal is converted to the adult.

The development of pattern in Smoky has been carefully observed and, in general, it would support the assumption that captive birds take longer to attain the adult plumage (Brewer, 1854), although some may reach maturity at the same age as wild individuals (Temminck, 1820). In consideration of the feathers produced by Smoky I can say that only the rectrices seem to approach the normal pattern.

A general understanding of pattern changes with age can be gained by an examination of feathers produced by a single follicle for each of the molts. Only three feathers in Smoky's tail have been molted during both seasons (*see* Text-fig. 5). In Plate 18, upper figure—a, b, c—I have illustrated the juvenal, immature and subadult feathers produced by the left central follicle. Feathers e and f are those produced by the right central follicle. Feather e (*see* Text-fig. 5) replaced the immature feather which dropped on June 7, 1945, but because of some irregularity of growth it was dropped on August 9, when but half-grown. The pattern is advanced over that of the juvenal feather

(see Plate 18, upper figure b) but does not approach that of c which replaced an immature dropped on August 11. The feather that replaced this partly grown plume, f, matches c in pattern. On November 6, 1945, I pulled c and it was replaced by the abnormally dark feather d which shows little or no pattern. The only other feather that had been replaced each molt is no. 2 (counting from the center) on the right side (g). The pattern of this feather is scarcely more than that of an immature, but the important point is that it is darker than any of the others and considerably darker than the feather it replaced (similar to b). Comparison of feathers e and c shows nicely the tendency for the pattern to darken as the molt progresses.

Using these pattern changes as a criterion for following the normal pattern changes of the wild bird, I will describe and discuss the various plumages which I have been able to distinguish in this species.

The first is the juvenal plumage. This is developed in the nest and worn for one year when it is partially replaced by 'immature' feathers. The tail of the juvenal bird is easily identified and well known to most ornithologists although, to my surprise, Spofford (1946) questions its validity.

In comparing juvenal feathers there is striking variation. In Plate 18 I have illustrated a group of juvenal tail feathers showing some of the differences. Feather c (Plate 18, lower figure) is the usual type. An extreme type is described by Baird, Brewer and Ridgway (1874) from the Boston Society of Natural History collection. "A young male from Massachusetts . . . has the tail plain black, the extreme base and tip white." The white tip is normal but usually wears off soon after the young leave the nest although indications of it may remain for some time. I have seen young in which only a glimpse of white could be seen, the rest being covered by the tail coverts. The most aberrant pattern I have seen is e (lower figure). This feather was taken from a young female in the Chalk Bluffs area of northeastern Colorado. The pattern of the other plumage was normal.

The juvenal plumage is blackish brown in tone, darker than that of the adult, somewhat lighter in the middle and lesser coverts. The bases of the feathers are clear white in sharp contrast to the dark tip which shows no marbling. There are no marblings of brown or gray at the base of the black terminal band of the rectrices although small spots or grayish lines may occur. The hackle color ranges from bright yellow to somber tan but is usually duller than the adult. The tarsi are dull tan as are also the margins of the feathers along the anterior border of the wing. White tarsi are not as uncommon as would be suggested by Eliot (1939) and others. As the North American sub-

species has been characterized by dark tarsi (Baird, *et al*, 1874), this point is of some interest. The tarsal color would seem to be a local variation. Of ten young eagles examined in northeastern Colorado, eight had almost pure white tarsi (two specimens 20674 CMNH and 130647 CM are from this area and have white tarsi). This type of tarsal coloration does not seem to be correlated with any particular part of the range but crops up here and there (*i. e.*, one specimen, 41993 CAS, from near Atlin, British Columbia). Light tarsi are associated with generally light colored plumage and golden hackles (approach *A. c. chrysaëtos*).

The juvenal feathers are characterized by more pointed tips than later feathers. This is especially true of the remiges and rectrices which are somewhat narrower in form than the replacing feathers. The tail feathers of the juvenal plumage are somewhat longer than those of older birds because of the apical point but the wing feathers of the older birds are somewhat longer. In general the new feathers are more generous than those that result from the "mass production" methods of the juvenal (*see* Plate 18, upper figure).

The next 'dress' which I will call the 'immature' plumage is produced by the first molt. It features the retention of a good percentage of juvenal feathers combined with new feathers. The 'immature' feathers are easily identified not only because they are wider and (if not worn) lack the point of the juvenals but, in addition, the pattern of the larger feathers shows a marbling of the white base. Variation in the style and amount of marbling are almost as extreme as the patterns of the juvenal feathers and all grades from a juvenal-like pattern to a heavily marked pattern can be found.

In the 'immature' plumage the hackles have gained the brightness of the adult and the leading edge of the wing is brightly marked with yellowish-edged feathers. The body feathers retain the juvenal pattern but the new dark feathers contrast sharply with the old feathers. The flights, secondaries, and scapulars approach the adult pattern but tend to retain some white at their bases and the marblings show a tendency for longitudinal streaking as well as transverse.

In Plate 19 I have illustrated the tail of an 'immature' bird. The approximate order of the molt is indicated on the figure. In Plate 20 the tail of a bird beginning its second molt is shown. Four feathers are missing from this tail but these were probably of the juvenal pattern. In contrasting the central tail feathers, the tendency for darkening of the pattern during the course of the molting season is well shown. In Plate 19 the decks were the first to drop while in Plate 20 they were among the last. A second point is that the pattern of the decks tends

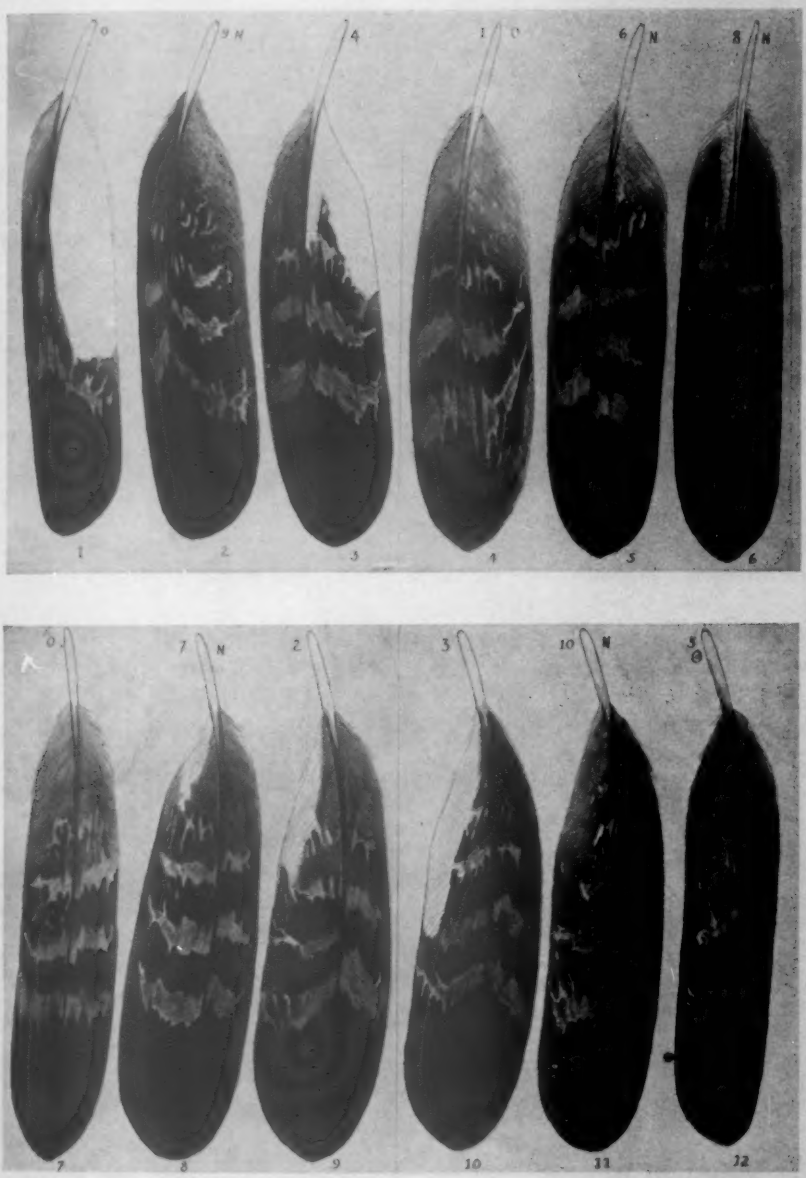
to be darker than that of the outer tail feathers. I have seen specimens (22745 CMNH) where the pattern of the decks did not show any real difference from that of the outer feathers but in the great majority the deck pattern is independent and tends to be darker. Among the outer feathers it is difficult to show any darkening of the pattern during the molting period although the oldest feather in Plate 20 has the lightest pattern and in the upper figure the no. 2 feather on the left side, which is just coming in, is the darkest. Individual variations would tend to obscure this pattern trend, but need not be taken as proof of its non-occurrence.

The plumage achieved by the second molt may be called the 'sub-adult' because I believe I have observed birds breeding in this plumage and because it introduces the first feathers of the adult pattern. Birds in this plumage retain only a few juvenal feathers and, essentially, appear adult except for the retention of these and immature feathers with their white bases. Reference to Text-figs. 2 and 5 will indicate the composition of wing and tail in Smoky at this time. In this plumage the entire tail has been molted once as have also the flights (occasional feathers may be missed) and three or four inner flights have molted a second time (up to the fifth primary in one case; 12511 CAS). A number of juvenal secondaries will be found in the wing of most individuals.

In Plate 21 I have illustrated the tail of a bird in this plumage. This particular tail is easily interpreted and makes a fine example. Feather 9 is a very worn juvenal feather missed in the first two molts while feathers 1, 3, and 12 differ from the rest in their striking patterns. Obviously 3 and 12 are feathers replacing 'immature' feathers while 1 represents a late, dark, 'immature' type. The appearance of fully adult feathers at the second molt was indicated in Smoky and has been substantiated by this specimen. Number 1 feather is doubtful, but its pattern is within the limits of the 'immature.' All 'immature' birds need not have adult pattern feathers as in some the tail is just replaced once with no feathers being molted a second time. In fact, one or two juvenal feathers may be retained in this plumage in exceptional cases. It is of interest to note that the juvenal feather in this figure shows indications of mottling. Marbling is quite unusual but such a pattern may be obscured by the heavy pigmentation of the usual juvenal feather.

The third molt produces the next plumage which is fully adult except for the retention of a few feathers of the 'immature' pattern in the wing and tail. This may be called the 'first adult.'

The tail of a (questionable) 'first adult' specimen is shown in Plate



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF BIRD IN AUTHOR'S COLLECTION SHOWING FIRST ADULT PLUMAGE. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

22. Although the exact age of this specimen cannot be determined it will serve to indicate a possible pattern. Number 1 feather is an 'immature' while numbers 4 and 7 are feathers retained from the subadult tail. This accounts for only three of the feathers and, as it is improbable that nine were replaced, one or more of the others is probably old. Old-appearing feathers beside 4 and 7 are 3, 9, 10 and 12. This tail pattern is possible mathematically. Assuming eight feathers to a molt (probably an abnormally high number), twenty-four feathers could be replaced. Actually only eleven have been molted twice while one has been replaced once, making a total of twenty-three replacements.

The order of molt for this tail cannot be drawn from an examination. The small amount of white at the bases of some of these plumes is of interest. *White appears at the base of many 'adult' feathers produced at this time.* Many specimens that have retained juvenal feathers up to this molt produce very dark immature types in replacement as in Plate 21.

The final plumage is that of the adult and is assumed usually with the fourth molt (or fifth). It would seem to me that there is considerable individual variation in the achievement of the adult plumage. If variation does exist, age may be only poorly related to pattern, and if some birds retain white in the tail, they are no less adult than those that do not. If lack of white were essential to the 'adult' pattern some birds might conceivably never become 'adult.' Naumann (1820–1847) told of an individual held in captivity 20 years without eliminating the white from the base of the tail, and Severtzov (Menzbier, 1894) based one of his species on adults retaining white in the base of the tail at all ages. It may be that in the American subspecies, white is never retained after an age of about four years, but this is yet to be demonstrated.

Adult rectrices are as variable as other stages. Some have three or more bands of light gray while others have but two. Specimens 352748 and 448106 AM show no markings. The style of banding of the rectrices was described by Spofford (1946) as "goshawk style," but this seems to me to be a poor characterization. The goshawk pattern is common throughout the '*Aquilidae*' but does not apply to the Golden Eagle. The gray bands of the eagle feather are best described as irregular gray marblings.

In summary several facts stand out. There is no particular order to the molt of the tail, and the number of feathers dropped is variable, usually becoming less with age (adults usually showing about four). The pattern of a feather tends to darken according to the date of

replacement as would be expected in view of the gonadal theory, although the individual variations may obscure it. The pattern seems also to be controlled by the number of feathers produced by the follicle and these can be classed as 'juvenal,' 'immature' or 'adult.' The pattern of the deck feathers is somewhat darker than that of the outer feathers. Three age plumages can be recognized before the attainment of the 'adult,' and this is essentially achieved at an age of three and one-half years, in the 'first adult' plumage. (The age at which a completely adult plumage is achieved is individually variable.) The development of pattern is not just a simple "clouding" or "marbling" of the white base of the juvenal feathers but is rather a complete reorganization of pigmentation with each pattern. Variability is the only constant in the plumage of this species..

Another plumage character of interest is the occurrence of white scapular patches. Spofford (1946) described a male in which "there was a clear white 'epaulette' in the upper part of each scapular tract, which showed clearly only when viewed from in front as the eagle lowered its head to feed. . ." Naumann (1820–1847) figured one specimen and described a second seen in the vicinity of Köthen on the Elbe, which had shoulder patches nearly as large as those of *Aquila heliaca*. Severtzov (Menzbier, 1894) saw an adult in captivity for 20 years which had small white scapulars at the insertion of the humerus and described a young bird in the juvenal plumage with small epaulettes. Further on he stated that he had found "traces, more or less insignificant, on 8 of 70 examples. . ."

In my own experience I have never found white epaulettes on any of the over eighty specimens which I have examined, nor have I observed them in the field. It is my opinion, however, that single white feathers in the hind neck or shoulder region are quite common. An adult observed at the nest during the spring of 1947 in New Mexico showed small white patches at either shoulder in flight.

The question of the significance of this trait is easily answered. If we consider the 'Aquilid' group, we find white epaulettes cropping up among the various species. Engelmann (1928) noted this fact and commented on the occurrence of white feathers in the shoulder and back of the Golden Eagle and compared this with their occurrence in the Booted Eagle (*Hieraaëtus pennatus*) and in the Imperial Eagle (*Aquila heliaca*). To Engelmann's account I can add that such epaulettes are found in *Hieraaëtus fasciatus* (Dresser, 1871–1881, and Swann, 1933) while in *Aquila verreauxi* the entire back and rump are white as well as some of the scapulars. This character seems to be

common to most of the members of the group and is of phyletic significance.

A last variable which I will discuss is that of eye color. Again Spofford can be cited. He described the eyes as reddish, "somewhat similar to *Accipiter* (?)." The color of eyes has also been commented on by Severtzov (Menzbier, 1894). "The color of the iris varies also with age. That of the young of the year is of pure brown, rather dark; that of the adult, of the third plumage, of a reddish cinnamon, which brightens with age until it is a brownish orange." Rothschild and Hartert (1912) described a male (535120 AM) taken in Algeria. "Its iris was dull yellow, variegated with rufous brown; . . ." Engelmann (1928) commented that "Das prächtige Auge ist mittelgross, von stechendem Ausdruck, in der Jungend bräunlich, im zweiten Jahre braunrot und später oft brennend rotbraun. Der Mann hat meist leuchtendere Färbung. In Gefangenschaft aufgezogene Stücke erreichen diese Farbhöhe viel später oder überhaupt nicht, sine Tatsache die wir bei vielen Greifen wiederfinden."

Among the hawks in general, eye color seems quite variable and does not seem to be correlated with sex although it is with age. In one female Cooper's Hawk that I had, the eyes were a bright ruby red, just as in the adult Goshawk. Other Cooper's Hawks had eyes ranging from bright reddish orange to yellow. The same extremes are found in the Sharp-shinned Hawk. Eye color in Red-tailed Hawks is also variable. Most examples begin to assume a yellow eye at an age of four or five months and by the first winter are of the adult type. One female that I possessed retained the juvenile eye even when in the adult plumage.

In my own experience with the Golden Eagle I can confirm Engelmann's remarks. I have observed two males and two females closely at the nest and can say that the eyes of the males were in both cases a bright hazel to yellowish color while the females had dark brown eyes scarcely lighter than juvenile birds. It is my guess that eye color is a secondary sexual characteristic, reaching its peak during the breeding period and becoming browner during the summer and fall. In the future, eye color should be noted for every specimen.

The history of research concerning eagles has been rife with error. I do not feel that this paper is free from error nor do I feel it marks the 'last word.' I hope it will arouse some discussion which will be helpful in bringing to light new ideas and interesting specimens. In view of this paper's preliminary nature, I hope to be able to add to the ideas here and expand the coverage of the discussion to all the subspecies at a later date.

SUMMARY

I have attempted to treat the problems of molting and plumage changes of the American subspecies of the Golden Eagle. I have not attempted to define subspecific variations of pattern which I believe exist. I have shown that a complete molt is accomplished in two seasons although some tracts undergo a more than 'partial' annual molt. Plumage variations are extreme, but three classes of patterns are described; a 'juvenal,' 'immature', and 'adult.' These pattern classes are variable within limits and represent the first, second and third feathers produced by each follicle. Pattern type is controlled first by the number of feathers produced by the follicle and secondly by the date at which the feather is replaced as related to a hormonal theory of pattern determination. I have described four age plumages before the full adult stage is reached. An 'adult plumage' is achieved at the close of the third molt at an age of 3½ years although another molt may be needed to rid the plumage entirely of immature feathers.

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NOTES ON MEXICAN BIRDS

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THESE notes relate chiefly to some of the birds collected by the senior author between August 8 and September 12, 1946, while he was a member of a party led by Mr. Charles M. Bogert and including Drs. A. P. Blair and John M. Moore and Señor Rodolfo Ruibal y Cuevas, all of whom were of valued assistance in the field.

The localities mentioned are as follows:

LAS DELICIAS, COAHUILA (about 26° 20′ N. Lat., 103° W. Long.).—This desert hamlet lies in a valley almost entirely surrounded by rather barren mountains. It is about 35 miles northeast of San Pedro, Coahuila. Conspicuous plants are prickly pear and cholla cactus (*Opuntia*), *Yucca*, mesquite (*Prosopis*) and, in the canyons, desert willow (*Chilopsis*). Permanent springs in two of the canyons supply water for a pond, small irrigated fields and a few fig and mulberry trees at the village, which attract many birds. There are no cottonwoods. Flickers (*Colaptes*) and Golden-fronted Woodpeckers (*Centurus aurifrons*) were absent.

SALTILLO, COAHUILA.—A little work was done near this city in country similar to that about Las Delicias but somewhat better watered and with larger yuccas and mesquite. *Colaptes* and *Centurus* were common.

RÍO NAZAS, DURANGO.—We worked along this river at a point about 15 miles southwest of Lerdo (about 25° 20′ N. Lat., 104° W. Long.). The river is lined with large cottonwoods and willows inhabited by Golden-fronted Woodpeckers, though no flickers were seen. The barren hills near by were not worked; mesquite and creosote bush (*Covillea*) were present there.

ZIMAPAN, HIDALGO.—This town on the International Highway also lies on the arid plateau but in a relatively well-watered region with large yuccas and prickly pear and candelabra cacti. Flickers and Golden-fronted Woodpeckers were common.

JACALA, HIDALGO.—This town is also on the International Highway but in a region of rugged mountains which are covered with a rather sparse forest of pine, oak and some cedar.

The mixture of late nesting with early migration records in the following observations is believed to be of interest. We have used subspecific names only when based on direct comparison of our specimens. The curators of the National Museum kindly permitted the junior author to compare some of our specimens with material in their collections. Wing measurements are of the chord.

Cathartes aura.—On the evening of August 25, while in camp on the Río Nazas, a heavy storm approached from the mountains to the eastward. As the wind preceding this storm picked up, a great concentration of Turkey Vultures, numbering over five hundred and probably nearer to one thousand, appeared. All were sailing on set wings at varying elevations but without deviation up the river valley towards the mountains farther west. Some Black Vultures (*Coragyps atratus*) were said by other observers to be mixed with the vanguard. It took about ten minutes for this great flock of vultures to stream over. They were evidently moving many miles to escape the heavy rains which fell farther east. Near camp where the rain was light the Turkey Vultures evidently did not join this movement, as just at dark about thirty were circling low over the cottonwoods in a confused fashion, the only time such behavior was noted.

A specimen from Las Delicias has wing, 490; tail, 242 mm.; and one from the Río Nazas: wing, 495; and tail, 250. These measurements are typical for the small Mexican race (*aura*) which is perhaps here near its northern limit on the plateau. Along the coasts it has been recorded north to 28 degrees N. Latitude in Sonora by van Rossem (1946) and from Brownsville, Texas, by Brandt (1936).

Callipepla squamata.—A Scaled Quail from Las Delicias taken August 18 was only two-thirds grown, though well able to fly. An adult from nineteen miles west of Saltillo was typical *squamata*.

Porzana carolina.—A Sora appeared about the pond at Las Delicias on August 15 and was killed by a Mexican. It was an adult male with testes still somewhat enlarged. An immature bird was taken August 25 along the Río Nazas.

Larus atricilla.—On August 21 we saw a young Laughing Gull along the Río Nazas. It seemed rather sluggish and when collected on the 24th proved to be in poor flesh. Its occurrence on the plateau must be casual.

Zenaida asiatica mearnsi.—An adult male Western White-winged Dove collected at Las Delicias on August 14 has the wing 166 mm., so belongs to the western race.

Columbigallina passerina.—A Ground Dove taken on the Río Nazas on August 24 was apparently still in breeding condition (testes about 8 x 3 mm.), although the wing was in molt and the rectrices were new.

Bubo virginianus mayensis.—A Yucatan Horned Owl from Las Delicias (probably a male of the year) has the wing 325 mm., so presumably belongs to this small race.

Centurus aurifrons.—An immature male Golden-fronted Woodpecker from Zimapan, Hidalgo, taken September 1, has the blackish streaks on the breast much broader and more pronounced than in any other specimen in this plumage we have examined. The flanks and under tail-coverts are also more heavily marked with dusky than usual and the forehead and crown more blackish. The breast is quite grayish, not buffy. Unfortunately we lack other material from this far south for comparison.

Empidonax wrightii (*oberholseri* auct.).—A Wright's Flycatcher was collected at Las Delicias on August 15, an early migration date.

Empidonax minimus.—Two Least Flycatchers were taken at Las Delicias on August 12.

Empidonax traillii adastus.—An example of the Great Basin race of Alder Flycatcher was taken at Las Delicias on August 11.

Contopus richardsonii.—A Western Wood Pewee taken at Las Delicias on August 18 is of the nominate race. One from the Río Nazas, August 23, is *sordidulus*.

Nuttallornis borealis.—The Olive-sided Flycatcher was first noted at Las Delicias on August 16, when one was collected.

Pyrocephalus rubinus.—A male Vermilion Flycatcher was seen feeding a fledgling near the Río Nazas as late as August 25.

Stelgidopteryx ruficollis psammochrous.—An adult Sonora Rough-winged Swallow, mostly in fresh plumage but with the wing in heavy molt, was taken from a group of half a dozen over the Río Nazas on August 24.

Auriparus flaviceps.—The unmistakable nest of a Verdin containing young only a few days old was found in a mesquite at Las Delicias on August 12. The species was seen near by, though not observed to visit the nest.

Mimus polyglottos.—A young Mockingbird out of the nest was observed begging for food from an adult on August 18 at Las Delicias. The species was quite common there but surprisingly shy, as Burleigh and Lowery (1942: 199) noticed elsewhere in Coahuila. At Las Delicias this could scarcely be the result of persecution for cage birds (the explanation suggested by Burleigh and Lowery).

Toxostoma curvirostre.—A female Curve-billed Thrasher taken twenty miles west of Saltillo had the ovary enlarged and a brood patch still somewhat evident on August 27. The plumage was very worn.

Vireo belli medius.—Dr. Blair found the nest of a Texas Vireo near the Río Nazas on August 25. It was about four feet high in willow sprouts beneath tall trees. The two young were in the pin-feather stage. One parent, collected while it was feeding the young, proved to be the male.

Dendroica petechia sonorana.—Sonora Yellow Warblers were common and singing freely along the Río Nazas. Unfortunately the only adult secured (August 22) was too badly shot for examination of the gonads to be satisfactory.

Dendroica townsendi.—A Townsend's Warbler was secured from a mixed flock of gnatcatchers and other species in mesquite about twenty miles west of Saltillo on August 28. This warbler rarely migrates on the desert in fall.

Geothlypis trichas.—Yellow-throats were common in beds of weeds near the Río Nazas. They were still singing freely. A male taken August 24 had the testes much enlarged. Its plumage was excessively worn.

Icteria virens.—A chat taken along the Río Nazas on August 24 seems nearest *auricollis* but is small: wing, 72; tail, 79. The ear-coverts are not blackish as they are said to be in the small race *tropicalis* from southern Sonora.

Wilsonia pusilla.—A Wilson's or Pileolated Warbler was seen at Las Delicias on August 17.

Xanthocephalus xanthocephalus.—Two adult male Yellow-headed Blackbirds were taken at Las Delicias (August 11, 15). They were the only members of this species observed.

Icterus parisorum.—Scott's Oriole was not uncommon in the arroyos near Las Delicias. On August 15, a bird barely out of the nest and able to fly only a few feet was taken as the female flew about near by. Another taken August 18 had the wing and tail not quite fully grown and represents a brood brought off a little earlier. A grown juvenile was taken August 13. This is later than the species is known to nest further north.

Icterus spurius ?affinis.—Orchard Orioles were common in the desert about Las Delicias throughout our stay. All the specimens taken were very fat with minute gonads and apparently were migrants. As compared with average specimens of *spurius*, an adult male from Las Delicias appears rather dark. Two in immature plumage (one female, one non-sexed) are dark and sooty above with reduced wing-bars and edgings. Below they are also rather dull and dark flanked. These three specimens are smaller and have shorter tails than most *spurius* and seem to be like the population of the Brownsville region of Texas that was named *affinis* by Lawrence. We have measured the type of *affinis* and the Las Delicias specimens. They are compared with additional measurements copied from Ridgway (1902: 276):

	Male		*Female*	
	Wing	*Tail*	*Wing*	*Tail*
Type of *affinis* (ad.)	74.5 mm.	63.5 mm.		
Las Delicias	77 +	66	73.5 mm.	64.5 mm.
southern Texas (series)	76.2	66.3	71.1	64.8
Atlantic coast (series)	79.2	68.8	75.9	67.3

The non-sexed immature from Las Delicias measures: wing, 73.3; tail, 66.

Although these differences are not striking, examination of adequate known breeding material from southern Texas may show that *affinis* is a valid race with differences in size and color.

Cassidix mexicanus prosopidicola.—Mesquite Grackles abounded around the Mexican village at Las Delicias. A worn adult female seems nearest *prosopidicola*. A fledged young was noticed begging for food from an adult an August 18.

Molothrus ater.—A flock of cowbirds was noted about the village at Las Delicias on our arrival. Of four specimens taken, two (August 15, male ad., female juv.) are of the race *ater* and two (August 15, male juv.; August 17, male ad.), *artemisiae*. Since *obscurus* must be the breeding race here, these records are early.

Piranga ludoviciana.—An adult male Western Tanager was taken at Las Delicias on August 12.

Pyrrhuloxia s. sinuata.—An immature Pyrrhuloxia taken at Las Delicias on August 10 has the wing, 91; tail, 103.5 mm. It evidently belongs to the race *sinuata* which we consider to differ from *texana* by larger size (particularly longer tail). Van Rossem (1934: 355) found that the type of *sinuata* (type locality "western parts of México," later restricted to Zacatecas) and other specimens from that part of México do not differ in color from *texana* (type locality Corpus Christi, Texas). He considered *texana*

a synonym of *sinuata* but did not discuss size variation. Van Rossem kindly informs us that the type of *sinuata* measures: wing, 94; tail, 101 mm. This is slightly less than the measurements listed below of five *males* of *sinuata* but a larger series would doubtless show overlap. Furthermore, the type may not be a fully adult male. It is an old specimen, probably once mounted, so its wings and tail may be somewhat blunted by prolonged abrasion and handling. Hence it seems justifiable to retain Zacatecas as the type locality of *sinuata* even though the exact source of the type is unknown.

Pyrrhuloxia sinuata beckhami Ridgway is a synonym of *P. s. sinuata*. Although Ridgway stated that the type is from El Paso, Texas, the specimen which he actually selected as the type is a specimen which, even in Baird's day, had lost its label and its designation as type was most unfortunate. It appears, however, to be of the western Texas and New Mexico race, measuring: wing, 95.8; tail, 105.7 mm. It is a male in late winter plumage, and it seems possible that it was the male (U. S. National Museum 4028) taken by Couch in "Tamaulipas," March, 1853; Baird's notes on the latter give it as from Nuevo León and say: "not here." Perhaps, therefore, No. 4028 had lost its label.

Curiously, the type of *texana* appears even longer-tailed than the type of *beckami*, but this proves on closer examination to be due to its tail having been shot. The feathers appear to have come out and to have been glued in. The wing measures 91.7 mm. Unfortunately the type of *sinuata* is another bird of unknown locality and van Rossem (1934: 355–357) gives no measurements. It is possible, therefore, that *sinuata* is the proper name for the race here called *beckhami*.

Specimens	*Wing*	*Tail*
8 ad. male *texana*	88–94.7 (91.6)	93– 102.7 (98)
15 ad. female *texana*	85–94 (88.9)	91.2–100 (95.5)
5 ad. male *sinuata*	95–99 (96.3)	102.4–110 (106.4)
5 ad. female *sinuata*	89–95 (92.1)	100– 107 (103.5)

Specimens with very worn tails (for the season) average decidedly shorter-winged and are doubtless immature. Tail measurements are about the same, however, in most cases, but occasionally immature *sinuata* are as small as adult *texana*. The figures given above for *texana* are probably correct, but the small series of *sinuata* may include some immatures.

Pheucticus m. melanocephalus.—An immature male Rocky Mountain Grosbeak taken near Jacala, Hidalgo, on September 9 is definitely big-billed and a migrant of this subspecies which was also recorded by Sutton and Burleigh (1940: 183).

Guiraca caerulea eurhyncha.—An adult male Blue Grosbeak from Las Delicias (August 12) and a pair from the Río Nazas (August 23, 24) are large-billed and belong to the race *eurhyncha*, which is perhaps here near its northern limit. Specimens from Sabinas, Coahuila and Rancho Baillón, northwestern Durango are *interfusa*. In the limited material examined we cannot find characters to separate *deltarhyncha* van Rossem from *eurhyncha*.

The Las Delicias male seemed well past breeding condition but the pair from the Río Nazas had the gonads considerably enlarged and the male was warbling softly. Others were seen that appeared to be concerned about fledged young, although the latter were not positively identified.

Passerina ciris pallidior.—Two immature Western Buntings, apparently migrants, were taken at Las Delicias on August 10 and 11.

Chondestes grammacus.—Lark Sparrows appeared about Las Delicias on August 18 (or possibly earlier) when one was taken. Thereafter they were common.

Amphispiza bilineata.—On August 8 and again on the 28th, Desert Sparrows were seen feeding fledged young near Saltillo.

Spizella passerina arizonae.—Two Western Chipping Sparrows were taken from a flock of four or five that were found near Las Delicias on August 17.

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THE RACES OF THE GRAY-HEADED FLYCATCHER [*CULICICAPA CEYLONENSIS* (SWAINSON)][1]

BY H. G. DEIGNAN

IT is likely that no Oriental bird has been the subject of so many revisions, with so little agreement among the authors, as this little flycatcher. An instructive résumé of the conflicting results is given by Kuroda ('Birds of the Island of Java,' 1: 226–227, 1933).

Through the courtesy of the Academy of Natural Sciences of Philadelphia and the American Museum of Natural History, I have added to the long series of the species in the U. S. National Museum to make a total of 262 adult specimens from virtually every part of its range; among them are six types of forms named by Oberholser and topotypes of most of those named by others.

It is my opinion, after careful and prolonged study of this material,

[1] Published by permission of the Secretary of the Smithsonian Institution.

that the characters assigned to most of the putative races result from such factors as soiling, wear, and poor preparation viewed in too short series. So vague are the distinctions that I, myself, can see in the majority of populations, that I should find it quite impossible to describe them in words and am by no means certain that they are not largely subjective.

I admit five races of the species *ceylonensis;* four are more or less well defined, but the fifth, an intermediate scarcely worthy of recognition, is accepted simply because it does not really agree with anything else and happens to have a valid name already available.

1. **Culicicapa ceylonensis calochrysea** Oberholser

"*Cryptolopha cinereocapilla* (Vieillot)" Hutton, Jour. Asiat. Soc. Bengal, 17 (No. 2): 689, Dec. 1848 (Himalayas).—Nomen nudum!

Culicicapa ceylonensis calochrysea Oberholser, Smithsonian Misc. Coll., 76 (No. 6): 8, July 16, 1923 ("Quaymos, Choung, Thoungyin River" = "Quaymoo Choung" = the right bank of the Thaungyin River, at about lat. 17° 15′ N., Amherst District, Tenasserim Division, Burma; see Deignan, Bull. U. S. Nat. Mus., 186: 459, 1945).

Culicicapa ceylonensis orientalis Stuart Baker, Bull. Brit. Orn. Club, 44: 11, Nov. 5, 1923 (Szechwan Province, China).

Culicicapa ceylonensis pallidior Ticehurst, Bull. Brit. Orn. Club, 47: 108, Mar. 25, 1927 (Simla, Ambala District, Punjab Province, British India).

Eye ring white; upper half of head deep ashy gray; remaining upper parts golden olive green, more golden on the rump; remiges and rectrices blackish, edged externally with golden olive green; throat and upper breast pale ashy gray; remaining under parts golden yellow, suffused with olive.

Range: Northern India (from the Afghan frontier along the Himalayas to northeastern Assam); Burma (south to northern Tenasserim); Siam (north, northwest); China (Szechwan, Yunnan); Indochine (Tongking, Laos, Annam).

Remarks: The birds of southern Annam show approach to the following form, but are best kept under this name.

2. **Culicicapa ceylonensis antioxantha** Oberholser

Culicicapa ceylonensis antioxantha Oberholser, Smithsonian Misc. Coll., 76 (No. 6): 9, July 16, 1923 (Khao Soi Dao, peninsular Siam at lat. 7° 20′ N., long. 99° 50′ E.).

Culicicapa ceylonensis meridionalis Stuart Baker, Bull. Brit. Orn. Club, 44: 12, Nov. 5, 1923 ("Keo, Tung Song" = Sathani Thung Song, peninsular Siam at lat. 8° 10′ N., long. 99° 40′ E.).

More or less exactly intermediate between *calochrysea* and *ceylonensis* in depth of coloration.

Range: Indochine (Cochinchine, Cambodia); Siam (east, southeast, southwest, peninsula); Burma (southern Tenasserim); Malaya (north).

Remarks: Between the ranges of *calochrysea* and *ceylonensis* occurs a broad zone of intergradation; the birds of this area, a little too dark for *calochrysea*, a little too bright for *ceylonensis*, may conveniently be known by Oberholser's name, although they hardly deserve a special appellation. The range outlined above is only roughly correct, since just where *antioxantha* begins and leaves off must be largely a matter of opinion.

3. Culicicapa ceylonensis ceylonensis (Swainson)

Platyrhynchus Ceylonensis Swainson, Zoological Illustrations, (ser. 1) 1 (No. 3): pl. 13 and text, Dec., 1820 (Ceylon).

Cryptolopha poiocephala Swainson, *in* Jardine's Naturalist's Library, 21 [Ornithology, 10 (Flycatchers)]: 200, pl. 23, May 1838. New name for *Platyrhynchus Ceylonensis* Swainson, 1820 (Ceylon).

Culicicapa ceylonensis percnocara Oberholser, Smithsonian Misc. Coll., 60 (No. 7): 12, Oct. 26, 1912 (Simalur Island, Barussan Islands, Indian Ocean west of Sumatra).

Culicicapa ceylonensis amphiala Oberholser, Smithsonian Misc. Coll., 60 (No. 7): 12, Oct. 26, 1912 (North Pagi Island, Barussan Islands, Indian Ocean west of Sumatra).

Culicicapa ceylonensis pellonota Oberholser, Smithsonian Misc. Coll., 60 (No. 7): 12, Oct. 26, 1912 (Samasama, Nias Island, Barussan Islands, Indian Ocean west of Sumatra).

Culicicapa ceylonensis pellopira Oberholser, Smithsonian Misc. Coll., 87 (No. 6): 9, July 16, 1923 (Mount Gedeh, at elev. 4,500 ft., Priangan Residency, West Java Province, Java, Indonesia).

Culicicapa ceylonensis eophila Oberholser, Bull. U. S. Nat. Mus., 159: 58, 1932 (Gunong Ranay, Bunguran Island, Natuna Islands, South China Sea.)

Similar to *calochrysea*, but with the upper half of the head a darker, more slaty, gray, and the upper parts a deeper, less golden, olive green, much less golden on the rump.

Range: Ceylon; southern India; Malaya (south); Natuna Islands; Lingga Islands; Sumatra; Barussan Islands; Java; Bali; Borneo; Paláwan.

4. Culicicapa ceylonensis connectens Rensch

Culicicapa ceylonensis connectens Rensch, Treubia, 13: 378, Dec., 1931 (Mao Marru, Sumba Island, Indonesia).

Similar to *ceylonensis*, but with the throat and upper breast albescent.

Range: Sumba.

5. **Culicicapa ceylonensis sejuncta** Hartert

Culicicapa ceylonensis sejuncta Hartert, Nov. Zool., 4: 526, Dec. 3, 1897 (southern Flores Island, Indonesia).

Similar to *connectens*, but with the throat and upper breast more or less strongly overlaid with golden yellow.

Range: Flores.

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CYCLIC INVASIONS OF THE SNOWY OWL AND THE MIGRATION OF 1945–1946[1]

BY ALFRED O. GROSS

THE cyclic nature of Snowy Owl invasions is now recognized and the appearances of the owls in large numbers has been correlated with the periodic maximum of Arctic foxes and the lemming cycle in the north (Gross, 1931, 1946). It is therefore desirable to review the records of the past before considering the migration of Snowy Owls into New England in 1945–1946. As might be expected, the records of the earlier migrations are very fragmentary since field observers were fewer in number and there was no coöperative effort to obtain records over the entire invasion area as there is today. A certain number of the owls appear each year, at least in the northern sections of the invasion area, and the individual reports of local concentrations during ordinary years tend to obscure the more pronounced cyclic invasions. It is also obvious that at a time when the cyclic nature of the migrations was not recognized some, especially the less pronounced invasions, were not adequately reported. However, in various journals and publications there are recorded twenty-four dates between 1833 and 1945 during which major invasions occurred. These are by no means of uniform intensity and they vary as to the region and amount of territory covered.

It is confidently hoped that even earlier records will be discovered and that the evident gaps in the series of dates presented in the following table may be filled.

[1] Contribution Number 18, Bowdoin Scientific Station, Kent Island, Bay of Fundy, New Brunswick, Canada.

TABLE 1

SNOWY OWL INVASION DATES

Date	*Interval*	*Date*	*Interval*	*Date*	*Interval*
1833–34		1886–87	4	1917–18	5
	4		3		4
1837–38		1889–90		1921–22	
	2		3		5
1839–40		1892–93		1926–27	
	14		4		4
1853–54		1896–97		1930–31	
	9		5		4
1862–63		1901–02		1934–35	
	4		4		3
1866–67		1905–06		1937–38	
	10		4		4
1876–77		1909–10		1941–42	
	6		3		4
1882–83		1912–13		1945–46	

1833–1863

We are indebted to the Canadian Journal (7: 522–523, 1862) for the early records of this period. There was a very marked invasion of Snowy Owls especially on the shores of Lake Ontario during the winter of 1862–1863. "W. H." writes: "The extraordinary numbers this year excite great attention, and arouse our curiosity respecting the cause." Another observer who signs his article "Strix" states: "In their migratory course, they seem to keep by the line of the Great Lakes, attracted, doubtless, by quantities of dead fish and waterfowl which at this season are strewn along the shore. In this vicinity a few are generally seen every season; but never in the recollection of the oldest inhabitant, have they appeared in such numbers as during the present month" [November, 1862]. S. Passmore, a Toronto taxidermist, reported that he had received 40 to 50 specimens in a period of two or three weeks. Mr. Passmore also stated that the Snowy Owls were very abundant in the Ontario region in 1833–1834, 1837–1838, 1839–1840 and 1853–1854. These records are for the Ontario region, but the migrations during these years probably also extended southward into northern United States as they do today. For example, Cyrus Eaton in the Annals of Warren, Maine, writes of the great numbers of Snowy Owls in Maine during the winter of 1837–1838, one of the dates mentioned above. No doubt an exhaustive search of the obscure annals and records published in the nineteenth century would serve to corroborate the other dates mentioned in the Canadian Journal as well as to fill in certain intermediate dates such as those between 1839 and 1853, an interval of 14 years.

1866–1867

There are several reports including statements by Ruthven Deane (1877, 1902) that there was a marked migration of Snowy Owls into the British provinces and New England during the winter of 1866–1867.

Since the invasions follow approximately a four-year cycle we would expect that one occurred about 1870, but available published records do not indicate that unusual numbers of Snowy Owls appeared at that time.

1876–1877

The winter of 1876–1877 was marked by an invasion of unusual magnitude throughout southern Canada, the middle-western states, New England, and southward. This migration was reported in considerable detail by Ruthven Deane (1877). Mr. Deane was of the opinion at that time that the invasions occurred every ten years, and cited the invasion of 1866–1867. Statements by Barrows (1912), Eaton (1914), and W. E. D. Scott (1879) and reports by various observers which appeared in current issues of Field and Stream all agree that the winter of 1876–1877 was one of the great invasion periods.

1882–1883

Another similar migration occurred during the winter of 1882–1883 as reported by H. K. Job (1883), D. H. Talbot (1883), William Dutcher (1885), Philip A. DuMont (1933, 1934), E. H. Eaton (1914), and others.

1886–1887

P. A. DuMont (1933, 1934), basing his information primarily on dated museum specimens, and Butler (1897) are authorities for a marked invasion of Snowy Owls to the middle-western states in 1886–1887. Fleming (1907) reports an unusual number in Ontario in 1884–1885 and also in 1888–1889. Frank Webster (1885) reported that seven of the owls were received from Massachusetts localities by November 12, 1885. The appearance of the owls in this period seemed to have been erratic and, as far as eastern United States is concerned, 1886–1887 does not rank as a major invasion period.

1889–1890

E. S. Cameron (1907) states: "During the winter of 1889–90 there was a regular invasion of Snowy Owls. J. D. Allen, taxidermist, Mandon, N. D. had 500 of them sent to him for preservation which I examined in May, 1890." Various notes in Forest and Stream (1889–1890) indicate a very general invasion of these birds throughout New England, New York, New Jersey and Pennsylvania. A. W. Butler (1897), E. H. Eaton (1914) and others also cite 1889–1890 as an important invasion period.

1892–1893

Ruthven Deane (1902) states that in 1892–1893 there was a very heavy migration throughout northeastern United States. According

to Otto Widmann (1907) and W. B. Barrows (1912) there was also a marked invasion into the north-central states that winter.

1896–1897

This invasion, while not pronounced in eastern United States, was very marked in the far west, especially in British Columbia and the State of Washington according to Allan Brooks (1917), J. Fannin (1897), and J. H. Bowles (1906).

1901–1902

The invasion of 1901–1902 was one of great magnitude throughout the region of southern Canada and central and northeastern United States. We are indebted to Ruthven Deane (1902) for a very complete report of this invasion based on solicited information from a great many observers distributed over a large area. In addition to Deane's report, O. Knight (1908), J. H. Fleming (1902, 1907), W. Barrows (1912) Sage, Bishop and Bliss (1913), Eaton (1914), Hoyes Lloyd (1923), and others have confirmed 1901–1902 as an important invasion period.

1905–1906

The invasion of 1905–1906, like that of 1901–1902, was also of great magnitude and over a large area according to R. Deane (1906), Amos W. Butler (1906), Ora Knight (1908), J. Swain (1905), H. Spinney (1906), P. A. DuMont (1934), W. H. Brownson (1905), and others.

1909–1910

The invasion of 1909–1910, judging from available records, was not as marked in New England as it was in the north-central states as noted by T. C. Stevens (1933), L. E. Hicks (1932) and DuMont (1933, 1934). There are also many individual reports of one or more Snowy Owls throughout the middle-west indicating the presence of many more birds than usual for that region. According to L. E. Hicks (1932) the owls also appeared in considerable numbers in Ohio in 1910–1911.

1912–1913

L. E. Hicks (1932) states there were many Snowy Owls taken in Ohio during the winter of 1912–1913, and this is confirmed by individual records, but this year was not marked by an unusual invasion of Snowy Owls into New England.

In 1916–1917 there was, according to S. F. Rathbun (1917), J. Hooper Bowles (1917) and Alexander Walker (1924), an unusually large invasion in Washington and the northwest, but it was not until the following year that the owls appeared in numbers in the east.

1917–1918

This migration was especially well represented by reports in the middle west as well as statements by Philip DuMont (1933, 1934) and W. Youngsworth (1933). More than the usual number of reports were made of the presence of these owls in New England but the invasion is not to be classed with the larger invasions in this section of the country.

1921–1922

The invasion of 1921–1922 was marked in the middle-west as well as in the east by many individual records, but like that of 1917–1918 was not of great magnitude.

1926–1927 AND RECENT INVASIONS

The Snowy Owl invasion of 1926–1927 was very general and one of the largest up to that time when judged by the number of owls reported killed and observed. More than 1000 records were received from New England alone. Detailed reports were made by A. O. Gross (1927), Sutton (1927), E. S. Thomas (1928), J. H. Fleming (1930), and others. From this invasion and for those that occurred subsequently I have had the opportunity to assemble the records of New England, particularly those of Maine which is near the center of the eastern invasion area. Since the cyclic nature of the invasions and their relation to life, especially to the lemming in the north, have been better understood, much greater interest has been taken in the invasions by an ever increasing number of field observers.

There are a few Snowy Owls reported each winter in northern New England, but about every three to five years (usually four years) there has been a large invasion of these birds (*see* Table 1). The magnitude of these migrations is variable. By basing estimates on the numbers reported by the same number of observers distributed in all parts of the state, it has been possible to assign an approximate comparative numerical value to the invasions of this period. Giving the 1926–1927 invasion an arbitrary value of 10, then the subsequent invasions would be approximately as follows: 1930–1931, 6: 1934–1935, 4; 1937–1938, 2; 1941–1942, 5; and 1945–1946, 12 as far as Maine is concerned. I do not wish to imply that "How Maine goes, so goes the rest of the invasion area," but the relative values expressed above will apply in a general way, at least to the New England area.

Because of the importance of the periodic invasions, a Snowy Owl Committee has been formed to collect the records over the entire invasion area. Such a task, by its nature, requires the coöperative effort of a very large number of field observers, the records of which

are assembled by the 14 members of the committee representing every section of the invasion area. A condensed summary and a map of the 1940–1941 invasion was published by the committee (L. L. Snyder, (1943). A report dealing primarily with the records obtained in New York State was published by Dayton Stoner (1943). The Snowy Owl Committee is at present preparing a similar report of the 1945–1946 invasion which will be published at an early date. The student of Snowy Owl invasions of the future is destined to have more complete reports than have been available for the past century.

The Snowy Owl invasion of 1945–1946 is, as was stated earlier, the largest on record as far as the number of birds reported is concerned. The members of the Snowy Owl Committee received reports of 13,502 Snowy Owls of which 4,443 were reported as killed. However, if these numbers are to be used for comparative purposes it should be emphasized that in the case of the two recent invasions, especially the one of 1945–1946, there has been more thorough reporting by a larger number of coöperators over a greater area than ever before.

The invasion of 1945–1946 extended into a vast area including the entire width of the continent from the State of Washington and British Columbia to the Atlantic seaboard. The lower limits of the invasion extended roughly along a line from Oregon, Montana, southern Nebraska, Iowa, central Illinois, Indiana, Ohio, and Pennsylvania to Maryland and south along the Atlantic coast. The most southern records that have come to my attention were one reported by A. D. Shaftesbury (1946) as captured alive on December 14, 1945, in Core Sound off Davis, Carteret County, North Carolina, and one taken at Charleston, South Carolina, on January 24, 1946. The heaviest concentration extended in a broad band from Alberta through southern Saskatchewan and Manitoba.

Since the other members of the Snowy Owl Committee are expected to report on the various areas represented by them, the present account of the 1945–1946 invasion is restricted primarily to conditions in New England. It will serve to supply many details which cannot be incorporated in the general report of the Committee.

I am greatly indebted to the state departments of conservation for their coöperation and to the many persons who assisted in obtaining and assembling the many records throughout New England. I am especially grateful to Mr. D. C. Alexander for compiling all of the reports received by the Massachusetts Audubon Society.

During the 1945–1946 invasion a record number of 2043 Snowy Owls were reported from New England which were distributed by states as shown in the following Table 2.

TABLE 2
NEW ENGLAND RECORDS OF SNOWY OWLS

State	*Snowy Owls received by taxidermists*	*Field observations*		*Total*
		Reported killed	*Observed alive*	
Maine	247	325	358	930
Massachusetts	81	74	318	473
Connecticut	112	25	173	310
Rhode Island	101	12	43	156
Vermont	94	3	14	111
New Hampshire	41	5	17	63
Totals	676	444	923	2043

Great care was exercised to avoid duplication of reports, but this was not always possible in cases where more than one observer may have reported on the same owl at different times. The above records are merely a representative sample since many owls were seen or killed that never were reported to us. Five thousand would be a conservative estimate of the number of Snowy Owls which visited New England during the period of the invasion. We were able to examine the specimens and records received by eight Maine taxidermists. Taxidermists in states such as Massachusetts and Connecticut where these birds are protected, reported totals but were unwilling to furnish data for obvious reasons. Some of them stated that they refused to accept any Snowy Owls because they considered it illegal to do so. Some of the owls received were probably from other states in many cases and hence the numbers received by taxidermists do not serve as an index to the relative abundance of the owls in the various states. They are important in measuring the magnitude of the invasion into New England as a whole.

In Maine, letters and questionnaires were sent to 105 state supervisors and wardens, to the keepers of 56 lighthouse stations, and to field observers in all parts of the state. From these a total of 683 reports of owls were received—325 as killed or found dead and 358 as alive. In addition there were 247 Snowy Owls received by eight Maine taxidermists, making a grand total of 930.

As in previous invasions, few of the owls were seen in the densely wooded sections of the state, but there were marked concentrations along the chief river courses and lakes and especially in the open areas along the sea coast and the islands lying well off the shore. According to the reports it was not unusual to see ten or a dozen of the owls on a single small island at one time. The keepers at Duck Island, Metinicus Rock, and Petit Manan lights made estimates of 50 Snowy Owls each

at their stations. Even allowing liberally for duplication, this indicates that an unusual concentration occurred on our outer coastal islands. One coast guardsman proudly boasted of killing nine of the owls at his station on a single morning. One lighthouse keeper reported that he had killed twelve of the owls in the course of a week. Mr. Ernest Joy, warden at Kent Island, saw 16 of the Snowy Owls at one time on October 18, the first day that they arrived. Mr. Joy examined the stomach contents of eleven of the owls killed by hunters in the vicinity of Kent Island and reported that two were empty; one had a mass of unidentifiable matter; one, green algae; one, barnacles and green grass; one, feathers and parts of a Herring Gull; one, a Purple Sandpiper; and four contained remains of Dovekies.

Mr. Robey Tufts, Chief Federal Migratory Officer, Wolfville, Nova Scotia, writes: "One reporter states that approximately 150 Snowy Owls appeared suddenly on Seal Island which is located at the most southerly point of Nova Scotia. This island is two and a half miles long and a mile wide. The island has been infested with house rats which live among the rocks and boulders above the high water mark. The owls have all but exterminated the rats on the island for which the people living on the island are very grateful." In a second letter dated March 1, 1946, Mr. Tufts writes: "Generally speaking, Snowy Owls have been found more abundant along the coastal areas where broad meadows and treeless plains exist than in the wooded interior of the province. On Bout Island, a small marshy area of 1,000 acres, adjacent to the shore of Minas Basin, Kings County, a flock of twenty Hungarian Partridges were seen during the middle of November. There was a pair of Snowy Owls present and when the island was visited again a month later the owls were again seen but the flock of partridges had been reduced to two birds. Clusters of feathers frozen in the ice and snow were seen in several places suggesting the birds had been killed there, presumably by the Snowy Owls." Mr. Tufts also states that a reliable observer from Antigonish County saw a Snowy Owl catch and kill a Black Duck in flight. Mr. Tufts examined the stomach contents of five birds of which two were empty, one contained a large house rat which had been swallowed whole within a few minutes before it was shot, one contained small mammals, either mice or moles, and another contained feathers of a Black Duck. One Snowy Owl was seen to fly up from the remains of a freshly killed hen pheasant. The examinations by Tufts and Joy and those of others confirm the variable nature of the food of the Snowy Owls, both favorable and unfavorable as judged from the standpoint of the interests of man (*see* Gross, 1944, 'Food of the Snowy Owl'). There are extreme cases

of behavior that clearly indicate the desperation to which the owls are driven in securing food when they arrive in a semi-starved condition after the stenuous migratory flight. A Snowy Owl made a swoop at an automobile near Baranga, Michigan, and made off with a squirrel's tail flying from the car's aerial. A warden writes that a Snowy Owl made repeated attempts to get his fur hat, and a hunter reports that he captured one of the owls alive when the bird flew at him and grasped his glove. A Maine trapper reports that on two occasions he found Snowy Owls in his steel traps set for wild cats.

During the major invasions, a considerable number of the Snowy Owls find their way into the midst of our populous cities, a strange environment compared to that experienced in their nesting haunts on the Arctic tundra. Some of them take perches in conspicuous places such as roof and chimney tops, flag poles and church spires where they never fail to attract general attention. The presence of the owls has even caused traffic jams, and at Lewiston, Maine, the police were called upon to shoot the victim that had inadvertently caused the trouble by attracting so many onlookers. Often the owls were stoned or harassed by boys who seem to have an instinctive urge to torment such creatures.

The persecution of the owls by the many hunters in the field during the open game season, a time when the migration is at its height, is most severe. This killing goes on even in states where the Snowy Owl is supposed to be protected by law. Some of the hunters feel they are contributing a service to their sport by killing all hawks and owls, an attitude encouraged by certain sports writers in their newspaper columns. Others kill these large, white, conspicuous birds out of mere curiosity or to satisfy a lust for killing. Out of 2043 Snowy Owls reported for New England, more than half, or 1120, had been killed (*see* Table 2). It is obvious that few of these attractive visitors pass the gauntlet of killers, and fewer of them ever live to return to the Arctic in the spring. This is borne out by the reports of the marked decline in the Snowy Owl population in the Arctic in the years following major invasions. Some observers in the middle-west have reported evidences of a return migration of the birds in the spring, but to my knowledge, no marked indication of such a movement has been observed in New England.

DATES OF ARRIVAL

During the 1945–1946 migration, some unusually early dates, as compared with those of previous invasions, were reported for New England. These dates are also earlier than the earliest reports from

the other regions of the present invasion. The earliest date of first appearance for New England was of a Snowy Owl taken at Kezar Falls, Maine, on September 15, 1945. The second earliest record was of one seen at Stratton, Maine, on September 29, 1945. On October 1 the first Snowy Owl appeared at Mt. Desert Rock lighthouse station. Mr. E. M. Horne, taxidermist of Hallowell, Maine, received the first owl for mounting on October 3, 1945. There are three records for October 10, as follows: a female shot at Caribou, Maine, one shot at Blaine, Maine, and another killed at Winthrop, Massachusetts. All three birds were preserved by taxidermists. There are 28 New England records for the last two weeks of October. Great numbers of the owls made their appearance during the first part of November but the peak was not reached in Maine until the last week of November and in southern New England the first week of December. Many were present through December and January, but after February and March there was a sharp drop in the number of reports. Whether this decline means a return migration had taken place or that the owls had been killed off cannot be determined; probably that both factors are involved. There are 14 records of Snowy Owls seen in April and four during the month of May. The last owl reported was one seen at Portland, Maine on May 14, 1946. Similar late dates were reported in New York State but not in the western sections of the invasion area in the United States. No June records were received for New England.

Dr. John B. May writes: "On June 17, 1946 I saw and took colored movies of an old, male Snowy Owl at Coin du Banc, about five miles from Percé, Quebec." Captain Duval reported that two or three Snowy Owls were on Bonaventure Island all spring. Mr. Burt Harwell informs me that he photographed one of the Bonaventure owls in June. Mr. Robert L. Grayce, a member of the MacMillan Expedition, saw a Snowy Owl at Gannet Clusters, Hamilton Inlet, Labrador, on July 9, 1946, and heard the call of another on July 10. There is of course no way of ascertaining whether or not these birds were returning from a visit farther south.

SNOWY OWLS AT SEA

As during past major Snowy Owl invasions, a large number of the owls have been reported as taking refuge on ships at sea. The following are typical of those that have come to my attention. E. M. Reilly, Jr., in a letter dated January 14, 1946, writes of two Snowy Owls which came aboard the troop transport U. S. S. General Le Ray Eltinge while traveling the Great Circle route between Gibraltar and New York City, on the morning of November 8, 1945. The ship at

the time was 1300 miles from New York City and 320 miles from Newfoundland. Mr. Reilly states the owls preferred the mattress radar aerial, mounted high on the mast, as a perch, where they created no little disturbance to the delicate instruments. Swinging the mattress had little effect but blasts from the whistle would cause them to fly. At such times the birds would circle the boat for an hour or more before returning to their perch on the aerial. When away from the boat the birds flapped their wings regularly but soared in the trough of the sea, and only when circling the ship for a landing would they arise more than fifteen feet above the water. Occasionally they seemed to drag their talons in the water but were never seen to feed on anything.

A Snowy Owl landed on the foremast of the transport James Parker on March 9, 1946, when the ship was 300 miles southeast of Newfoundland. It remained on its lofty perch for two days before it was finally captured alive and brought to New York City. Pictures of this bird were given wide publicity in the daily newspapers.

Chief Officer Barth F. Reed of the M. V. Acorn Knot, writes that on April 15, 1946, while on a voyage from Halifax, Nova Scotia, to Reykjavik, Iceland, a Snowy Owl came aboard when they were at 44° 41′ N. and 42° 35′ W., approximately 500 miles from the nearest land. Mr. Reed states that he does not believe the bird was blown out to sea by the winds.

I have received twenty-four reports of Snowy Owls which were observed on ships at sea and it is reasonable to suppose that many others took refuge in this manner, but it is probable that vastly greater numbers perished on the broad expanses of the ocean. Two lighthouse keepers stationed on extreme outer coastal islands of Maine reported seeing Snowy Owls flying from their islands or over their islands in a direction away from the mainland. These birds probably never lived to return. There is no way of ascertaining how many of the owls meet disaster in this way, but it must be great—greater than anyone has supposed. It reminds one of the fate of the lemmings at the time of their periodic migrations in northern Europe when hordes of these rodents are said to perish by rushing headlong into the sea.

A few of the owls succeed in surviving until they have traveled great distances over the Atlantic, perhaps by taking rides in turn on a number of ships along the main shipping lanes. Murphy and Chapin (1929) reported a Snowy Owl that was collected at Fayal, Azores, on January 14, 1928. It would be impossible for a land bird such as the Snowy Owl to survive such a long, continuous flight at sea. This bird undoubtedly took refuge on a ship or a number of ships or it may

have been carried in captivity on one of them from the western side of the Atlantic, as suggested by the authors, since the primaries of the specimen, now in the American Museum, are greatly frayed.

RELATION OF THE SNOWY OWL INVASIONS TO THE LEMMING CYCLE

The peaks of Snowy Owl abundance have been correlated with the years of periodic maximum numbers of Arctic foxes and other predators in the north (Gross, 1931, 1946). Both foxes and Snowy Owls are predators of mice, especially of the lemmings, and are dependent on them as their primary source of food. It is now generally accepted that the underlying cause of Snowy Owl invasions is the well-known cyclic fluctuations in the lemming and mouse populations.

In the barren lands of Arctic America there are at least seven kinds of mouselike rodents of which the lemming is the largest and most important. It weighs about 75 to 100 grams, about twice the size of the smaller voles and mice. The lemming has a short fur, a stumpy tail and a dark-colored dorsal stripe. The pelt of the lemmings belonging to the genus *Dicrostonyx* turns white in winter but that of *Lemmus* does not change color. The lemming is very edible, not only for predatory birds and mammals, but also occasionally for Eskimos, and even Arctic explorers have been known to eat them when food was scarce. The lemming is a voracious feeder and has extraordinary powers of reproduction and ability to increase, even after a period of scarcity.

Dr. Charles Elton (1942) has worked out the details of the lemming cycle in Ungava and Labrador. Similar conditions prevail in Baffinland and the western side of Hudson Bay, a great area of millions of square miles including the entire breeding area of the Snowy Owl. The lemmings increase over a period of three to five years—an average of approximately four years—from a low ebb to a maximum. The year of maximum abundance of lemmings is also a good year for the predators. The Snowy Owl fits into the picture somewhat as follows. The owl lays from six to eight eggs, and some nests have been found to contain as many as thirteen. When the eggs hatch, it requires a tremendous amount of food to feed such a large family. Ordinarily the mortality is great, with only two or three of the owlets reaching maturity. If the lemmings are scarce, the owls may not even attempt to nest. In a good lemming year, practically all of the large families survive, and thus the Snowy Owl population is built up to a peak along with that of the lemming. The same might be said of the other predators. Then with abruptness the '*crash*' comes.

The predators such as the foxes and the Snowy Owls that depend

primarily on lemmings for food must do one of two things—they either starve to death or they must find other sources of food. The foxes are able, by their cunning and adaptiveness, to secure other food, but many of them die of starvation and disease as the Hudson Bay records clearly indicate. The Snowy Owl, however, since it is able to fly, wanders far and wide, in years of extreme general scarcity of lemmings, even coming down as far as northern United States. It is clear that the migration of the owls is due to two factors: first, the great increase of the Snowy Owl population; and, second, the abrupt disappearance of their chief food, the lemmings.

Other predators of the lemming also exhibit, though not in such a spectacular way as does the Snowy Owl, the influence of the lemming cycle. Gyrfalcons, Rough-legged Hawks, Short-eared Owls, Ravens, shrikes, and others have usually been noted in increased numbers during the times of the Snowy Owl invasions. The lemming cycle exerts a profound influence on the ecology of the Arctic barrens. It is not only the basic cause of periodic migrations of predatory birds, but it also vitally affects the fur-bearing animals and thus the whole economy of the Arctic fur industry.

So intimately are the Snowy Owl migrations tied up with the lemming cycle that the migrations can be predicted if we have a knowledge of the status of the lemming. In August, 1945, I received a letter from Roland C. Clement, who had been spending a year at Indian House Lake, an enlargement of the northward-flowing George River which empties into Ungava Bay, northern Quebec. The area is typical Hudsonian Zone or semi-barrens. He told of the lemming crash and predicted well in advance the Snowy Owl invasion of 1945–1946. Mr. Clement is writing a most interesting paper on the natural history of Indian House Lake, P. Q., in which he gives an account of his observations of the lemming during the year of the crash. He has kindly allowed me to take extracts from a section of his manuscript, which has not yet been published, which are of interest in connection with the present invasion of Snowy Owls. Mr. Clement writes that in the fall of 1944 lemming burrows were numerous, and in places there were veritable colonies built into the banks above the bogs. These concentrations usually faced southward or southeastward away from the prevailing wind and they were consequently covered with drifted snow throughout the winter. The records of the activity of the lemmings on the snow revealed that they occurred wherever loose rocks were liberally scattered on good soil. Very flat fell-field or pure gravel beds which occurred locally were untenanted. The abundance of the rodents is strikingly revealed by such notes as those of two lemmings

found in a freshly-dug post hole, of three which were found in a sleeping bag of a man sleeping on the ground, and of mice that were found in trout and salmon cleaned by the cook.

Mr. Clement made a trace census during October of a series of forty-eight samples one meter square. Later, when the snow had been on the ground a while, he found 240 mouse trails across this thirty-two-hundred-foot course, of which 180 were made by *Dicrostonyx*, 40 by other Microtines and 20 by *Peromyscus*. After the snow appeared, lemmings seemed particularly active and evidently engaged in much wandering or random exploration because they often went out on the lake ice where they invariably were picked up by raptorial birds. Little piles of intestines gave evidence of their fate throughout October and November. During the first autumn, three instances of non-predatory mortality among mice were found. On October 20 a dead lemming was found on the tundra, on October 31 an uninjured lemming was found dead on the moss in thick spruce woods, and on November 21 a specimen of *Phenacomys* was found lying on the ice near the station. On December 1 Mr. Clement caught a lemming which died two days later after going through a series of nervous convulsions that suggested some form of encephalitis.

In late April, the melting snow revealed a labyrinth of tunnels but very few fresh signs of life. Only one fresh lemming trail was seen during the entire month. From May to August hardly one of Mr. Clement's walks, if extended a mile or more, failed to reveal at least one or two lemmings that had died under the snow. All of these were sprawled out flat and were in the gray coat, though most of them had the enlarged fore claws of winter. These half-dry carcasses were scattered here and there over the tundra. In August he found the skeletal remains of four lemmings at the base of a bluff. By trapping tests and by examining many sites that were populated the preceding year, Mr. Clement discovered striking evidence of the marked decline. No mice or lemmings were found in any of the salmon and trout caught in 1945 as there were the year before. Since all the lemmings found dead were in the gray phase, Mr. Clement thinks this may be interpreted as evidence of a spring crash.

In discussing the relationship of climate to the cycle, he states there were no weather records for comparison, prior to the year he was at the station, but at Chimo, on Ungava Bay, for example, there was an excess of temperature of about 14 degrees and a precipitation deficiency of about 11 inches in the period from September, 1944, to June, 1945. The actual snowfall recorded at Indian House Lake during this period was 35.4 inches, 10.8 inches of which fell in January during a freak

storm. The January, 1946, snowfall was less than three inches. Mr. Clement comments: "Although it is logical to expect low snowfall and consequent exposure to affect the over-all picture, it may be well to recall that the heaviest concentration[s] of lemmings were in areas that were protected by several feet of drifted snow, and these colonies nevertheless appeared to bear the heaviest mortality."

Because of our lack of a complete knowledge of the life history of the lemming in the different regions of the Arctic and since no one as yet had been able to observe conditions continuously during the period of an entire cycle, there are at present conflicting opinions concerning the underlying causes of the cyclic fluctuations of the lemming population. Disease has been suggested by Elton and others as a possible factor and Clement's observations in northern Quebec, of finding many dead and some disabled mice at the time of the crash, lend weight to this view.

Sunspots have been advanced as a possible basic cause of the periodic outbreaks of disease and conditions of the weather and thus as influencing the cycle. The Lockyers (1901–1902) have shown that there is a definite "four-year" cycle. Dr. Ralph DeLury's theory of the mechanism is that the hotter high-level prominences' faculae and flocculi are relatively great emitters of ultra-violet light, which by ionizing our upper atmosphere cause much of our electro-magnetic disturbance, followed by development of haziness, cloudiness, precipitation, and barometric and temperature variations. These in turn affect all forms of living things and their food. In a recent letter from Dr. DeLury of the Dominion Observatory, he states that he favors the idea of the meteorological effects, so evident in the four-year period determined by the Lockyers, as being a profound factor in the lemming cycle. However, V. E. Shelford (1943) states that there appears to be little correlation between large numbers of lemmings and sunspot numbers of ultra-violet light as observed at Mount Wilson. But he adds that no valid conclusions can be drawn from such a short period of observation.

Dr. Shelford (1943) has presented some interesting tentative conclusions, based on observations in the Churchill area, concerning the relation of weather to lemming populations. Increase depends upon: "The occurrence of more than average snowfall so distributed as to afford protection throughout the winter, in combination with temperatures above or near normal in the cold months. Two favorable years in succession are usually necessary to build up a peak population." In a recent letter received from Dr. Shelford he states further: "The lemming I now know breeds throughout the winter when there is snow,

and apparently fails to breed and suffers greatly from predation when there is little snow." He believes that no other explanation is necessary to account for the periodic crashes. (Shelford states that he has never found many dead lemmings!) Shelford's prey-predator hypothesis could explain the cycle if it were a simple oscillation of the Lotka-Voltera type, but he fails to account for a 'crash' that is unaccompanied by a high-predator population. (Mr. Clement reports very few raptores at Indian House Lake throughout the winter and spring.) Nor does the hypothesis take into account the natural mortality which Clement also found so marked at the time of the last crash in northern Quebec. It is highly probable that several decimating factors are at work, but that one of them is dominant under the conditions existing at the time of any particular cycle. The effect would be to mask the subordinate factors which, in some other year, might become the dominant ones.

The over-all picture is still hazy and there remains much more work to be done in the Arctic before it becomes crystal clear.

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SOME NESTING RECORDS OF THE SARUS CRANE IN NORTH AMERICAN ZOOLOGICAL PARKS

BY LAWRENCE H. WALKINSHAW

Plate 23

THE Sarus Crane [*Grus antigone antigone* (Linnaeus)] found in northern India, is non-migratory and breeds from the Indus River to Assam south to the Bombay Presidency and the Godavari River (Peters, 1934: 152). Colonel Ticknell (Blyth and Tegetmeier, 1881: 50) described seeing the Sarus Crane "in various parts of India—on the Nepal frontier, in Tirhoot, near Patna, Bhagulpoor, Rajmahal, Malda, Bankoora, Chota Nagpoor, Singbhoom, and near Sumbhulpoor, also in Arakan and Tenasserim."

An eastern race, the Burmese Sarus Crane (*Grus antigone sharpii* Blanford) is found in eastern Assam, Thailand, Burma and Cochinchina, French Indo-China. All of the breeding records at hand pertain to the typical Sarus Crane from India, the birds having the white neck stripe below the bare portion of the head and neck.

The Sarus Crane is generally bluish ash-colored in plumage with the tertials and a band below the upper neck white or nearly white. The primaries and secondaries are black or blackish. The iris is orange; bill greenish with darker tip; crown and upper neck bare, the skin on the crown pale ashy green; that on the head and neck orange red; that just above the feathers bright orange. The skin of the head and neck is covered with scanty black hair-like bristles. The auricular region is covered with patches of bluish ash feathers. The legs and feet are flesh-colored.

This crane is larger than the Greater Sandhill Crane (*Grus canadensis tabida* Peters). The measurements of one male from the American Museum of Natural History and four males and one female from the University of Michigan, all taken by Walter Koelz in Punjab, are here recorded. One female: Wing, 601 mm.; tarsus, 307 mm.; exposed culmen, 165 mm.; bare tibia, 182 mm.; middle toe, 136 mm. Five males: Wing, 645 mm. (625–675); tarsus, 333 mm. (299–352); exposed culmen, 177 (163–187); bare tibia, 200.2 mm. (185–210); middle toe, 140 mm. (128–152).

Evidently the first record of the Sarus Crane nesting and rearing young in captivity was made by the Moghul Emperor, Jehangir (1603–1627 A. D.; Journ. Bombay Nat. Hist. Soc., 32: 57–60, 1927) also recorded by Rothschild (1930: 67–68). Rothschild also described the nesting of Sarus Cranes in captivity at Tring, where a pair raised young after many failures. The female was about 20 to 25 years of

EGGS OF SARUS CRANE: LINCOLN PARK ZOO, CHICAGO, ILLINOIS, 1946.

age and the male, three to seven years. The first successful nesting in the United States apparently occurred in the Frank Vanderlip aviaries in southern California (Wigley, 1931: 54–56).

During 1946, Charles Coffman wrote me that the Sarus Crane was nesting at Lincoln Park Zoological Gardens, Chicago, Illinois. Thanks to Mr. R. Marlin Perkins, Director of the Zoo, I was able to spend a few days watching and photographing these birds at their nest. Mr. Perkins also gave me the records of two other zoological collections where he had known of the Sarus Crane nesting, and I have been able to get considerable information on the nestings from the three zoo officials. For the material which they have forwarded me, I wish to thank especially Mr. Perkins and Mr. George Irving of the Lincoln Park Zoological Gardens, Mrs. Belle J. Benchley, Executive Secretary of the Zoological Society of San Diego, California, and Mr. Fred Stark, Director and Mr. R. H. Friedrich, President, of the San Antonio Zoological Society, Inc., San Antonio, Texas. Most of the following material is what they have sent to me. I wish also to thank Robert Jickling of Chicago for preparing the eggs which are now in the University of Michigan Museum, Ann Arbor.

THE NEST

In the Lincoln Park Zoo the Sarus Cranes built their nest of straw (picked up from the ground), dead leaves, and twigs and small branches which had blown off neighboring trees. George Irving said they had nested for five successive years. The birds were procured in 1940 and kept in a rather large enclosure with a pool of fresh water through the center, extending from one end of the pen to the other. During 1942, 1943, and 1944, the cranes nested on a little stony island, about three feet across, out in a shallow portion of the pool, about 75 feet from shore. During 1945 and 1946, they nested on the shore two or three feet from the water's edge and only some 40 feet from where crowds of spectators passed daily.

At the San Antonio Zoological Society gardens, the Sarus Cranes were first obtained in 1939, began to nest during 1943, and have nested each summer since then. A photograph of the 1945 nest taken by R. Marlin Perkins showed the nest to be about 15 feet from the water. Mr. R. H. Friedrich and Mr. Fred Stark wrote that the first two nests were about 40 feet from the shore of the stream running through the enclosure, while the 1945 and 1946 nests were 15 feet from the shore. Hay, placed in the enclosure, was used for nest material.

The San Diego nest was placed on dry ground in a small enclosure within which the birds were kept. A similar nest was described by

Hartert and Young (1928: 75) who discussed the nesting of Lord Rothschild's cranes at Tring, England.

The 1946 nest at the Lincoln Park Zoo was 79 x 121 cm. in diameter and about 10 cm. deep, hollowed in the center for the eggs. The parents brought material to this nest even after September 1, working on it a certain amount each day that they were observed. With their bills they broke small twigs and branches off the larger ones that were blown from a near-by tree and threw them into a pile in the direction of the nest. The next time the incubating crane left the nest it would go to this pile and throw many of the branches again toward the nest which the materials eventually reached. Occasionally they would stand and work the twigs, grasses and leaves into the edge of the nest as they stood over the eggs.

Lord Rothschild (1930: 67) stated that the first nest that his pair built during 1925 was started on July 17 and the first egg laid July 20. Another nest built by this pair required two days during 1925 (Hartert and Young, 1928: 75–76), September 22 and 23. During 1926 a nest was hurriedly built on June 28 and an egg laid the same day, and a similarly carelessly constructed nest was built on August 29 of that year. On July 8, 1927, an egg was laid on the bare ground. The next day, July 9, a slight nest was built and the second egg laid in it the following day.

In the wild, Colonel Ticknell (1881: 49) quotes Jerdon as saying that the Sarus Crane nested "on some island or spot nearly surrounded by water, and that the nest is sometimes made in the water, and raised some inches above the surface." These nests were constructed of layers of grass.

A nest described by Marshall (Blaauw, 1897: 27) measured, after the rainy season, nine feet in diameter at the base and three feet in height, after settling a foot.

The Eggs

Most cranes lay two eggs, sometimes one and rarely three. Colonel Ticknell (Blyth and Tegetmeier, 1881: 49) stated of the Sarus Crane: "The eggs are almost invariably two in number, somewhat slender, oviform in shape, and of a dull yellowish white, sprinkled with small patches or drops of very pale brown, most thickly scattered over the big end. In some the brown marks are almost entirely absent, and the shell is thickly beset with porous indentations. The average size of the egg of the male chick is 4 in., and 2½ in. across; of the female 3¾ in. by 2½ in."

Two of the eggs (the third disappeared) in the 1946 Lincoln Park

Zoo nest are almost pure white (Plate 23). One is marked sparsely with lavender and brownish spots from 2 to 6 mm. in diameter mostly near the larger end. The other egg is much less marked and the spots are smaller, none exceeding 3 mm. in diameter, most of them 1 or 2 mm. Both eggs are pitted over the entire surface with very narrow pits about 1 mm. in length and mostly in rows along the long axis. On one egg several irregularly shaped pimples of egg-shell material are present; otherwise the shells are largely smooth with a hard and strong texture. The eggs are differently shaped; one is much more pointed at the smaller end.

After they had been incubated about 70 to 72 days these infertile eggs weighed and measured: (1) 101.0 x 65.5 mm.; wt., 142 grams; (2) 97.0 x 63.9 mm.; wt., 113 grams. After the eggs were blown, the shells weighed 24.5 and 21 grams, respectively.

Two Greater Sandhill Crane eggs, similar in size to the larger Sarus Crane egg, were found in Sharon Township, Washtenaw County, Michigan, May 5, 1940, and, when about half incubated, measured and weighed: (1) 101 x 64 mm., wt., 197.4 grams; (2) 103 x 65 mm., wt., 213.4 grams.

A newly laid Sandhill Crane egg found in Convis Township, Calhoun County, Michigan, on May 1, 1941 (the day it was laid or the day after) measured and weighed: 95.5 x 63 mm., wt., 200.0 grams.

Another set of two Sandhill Crane eggs taken in Johnstown Township, Barry County, Michigan, May 7, 1942, three days before hatching, measured and weighed: (1) 108 x 62 mm., wt. 166.5 grams; (2) 103 x 64 mm., wt. 174.8 grams.

One individual Sarus Crane at Tring (Hartert and Young, 1928: 75–76) laid nine eggs in one year. On several occasions she laid four or more eggs in two sets. Two eggs were usually laid at the San Antonio Zoo, except one year when only one egg was laid, and two in the case of the bird in the San Diego Zoological Collection. At the Lincoln Park Zoo, during a five-year period, sets numbered five, three, four, three and three eggs respectively, indicating that both the birds there were females.

The dates of first eggs laid at Tring, as recorded by Hartert and Young (1928: 75–76) and Rothschild (1930: 67–68) were as follows: 1925, July 20 and 22; 1926, June 28 and 30; 1927, July 8, 10 and 13; 1929, July 2 and 5.

In the Lincoln Park Zoo, the eggs were usually laid about mid-July; in the San Antonio Zoo, two eggs were laid during 1943 of which one hatched only to be lost in high water; one egg was laid during July, 1944, and the young were reared to maturity; two eggs were laid during

July, 1945, and both eggs hatched and the young were raised to maturity. During 1946, two eggs were laid during July and both hatched. One young died from pneumonia when three weeks old; the other is still alive. In the San Diego Zoo, two eggs were laid during August, 1943. The parents incubated them for a period of 35 days and then deserted them; the eggs apparently were not fertile. Mrs. Benchley wrote that on August 11, 1944, she "noticed they were nesting again; they probably had been on the eggs more than a day at that time. Thirty-one days later on September 11, one of the babies hatched and was moving out to the side of the mother; it might have been hatched 24 hours before. The next day I saw her off the nest with two babies." This would give an incubation period of about 32 days which is the approximate period given by Fred Stark of the San Antonio Zoo. Rothschild (1930: 67–68) gave the incubation period at one nest at Tring as 36 days, but incubation did not start when the eggs were first laid.

Hume and Marshall (1881: 9) told of Captain Butler taking eggs from nests where the cranes laid eggs later in the same nest. An example was given of a nest from which two eggs were taken on the 24th of August, another was taken on September 19. From a different nest he took an egg on September 19 and another from the same nest on September 23.

Blaauw (1897: 26) stated that the Sarus Crane nests during the rainy season, starting to nest at the end of June, then through July, August and September.

It is noted in the case of the Sarus Cranes at Tring that during 1925, when the two eggs were taken September 8, two more were laid September 23 and 27; during 1929, two eggs laid on July 2 and 5 were eaten but were replaced by the same female July 12 and 14, and these second eggs hatched August 19 and 20. More than 25 eggs were laid by this female during a five-year period and only two young produced. Eighteen eggs were laid by the Lincoln Park Zoo birds and no young produced, while four eggs in the San Diego Zoo produced two young. From seven eggs in the San Antonio Zoo, six hatched (the other was broken by the parents). Messrs. Friedrich and Stark write that both adults incubated the eggs, with the female evidently incubating at night; the male remained in the near vicinity all night but did not roost in the water which ran through the enclosure. He helped during the daytime. Lord Rothschild mentioned that the male alternated in incubating the eggs. At the Lincoln Park Zoo, both birds incubated, changing at irregular intervals. On the morning of September 1, the bird that did not incubate during the night was observed as it started

walking toward the nest. It had roosted in the shallow pond about 100 feet from the nest beneath the overhanging branches of a tree growing on the shore. The following notes were taken at this nest on August 11, 1946:

8:20 a. m. One Sarus Crane was feeding about 100 meters from the nest. The other, which we will call Parent 1, was sitting on the eggs.

8:40 a. m. Incubating bird left the eggs, walking out about 35 meters into the duck pond.

8:45 a. m. Parent 2 walked up through the water to the nest. Parent 1 stood in the water with wings half outspread as though begging for food. Parent 2 did not have any food so walked by to the nest, then repeatedly tried to work the nest material and eggs into a comfortable position, raising and lowering itself several times before finally settling down to incubation. It rolled the eggs about with the base of the lower mandible. Parent 1 was away inspecting all of the small chicken houses in the yard, going from one to another.

9:05 a. m. Parent 1 returned through the water to within 40 feet of the nest where it stood preening. It drank once much like a Sandhill Crane but stood preening for a long time. Parent 2 pecked at the nest material, working it around closer to its body, sometimes slightly raising its breast to tuck some underneath its body. It did not, however, raise up enough to show the eggs. Other birds gave it a wide berth as they passed by the nest. Even the gray squirrels, which were common in the park, kept their distance as they scampered by.

9:35 a. m. Parent 1 came out of the water toward the nest, then walked up to it and around the other bird which rose and stood for a minute. Parent 2 walked away to feed on some fish which the keeper had just thrown on the dry cement about 20 feet from the nest (although two had been thrown at the very edge of the nest, it had not offered to touch them.). It pecked the fish, threshing it around on the ground, and ate a few portions which were broken off. Parent 1 sat on the eggs facing in the opposite direction or west. Parent 2 went south from the nest following along the water's edge where it stood 100 meters away preening its wing and body feathers.

10:05 a. m. Parent 2 came back to 25 meters from the nest where it stood preening its feathers.

10:14 a. m. Parent 2 walked up to the nest and Parent 1 left. Parent 2 spent two minutes rearranging the eggs before settling down onto them, facing east. Parent 1 came back to the nest where it picked up one of the two fish thrown there by the keeper and, carrying it into the water, threshed it around in the water as if washing it, then ate small portions of it, leaving the remainder in the water. It finally waded to a spot about 12 meters from the nest and started preening.

10:30 a. m. Parent 2 incubated with eyes nearly closed while Parent 1 waded about in the water, stopping at times to preen.

10:40 a. m. Parent 1 came to the edge of the nest where it stood preening while Parent 2 pecked at the material on the edge of the nest as it sat on the eggs.

10:41 a. m. Parent 2 rose and walked away. Parent 1 walked onto the nest and immediately began to incubate.

10:45 a. m. I entered the Duck Pond enclosure and Parent 1 left the nest immediately but returned almost as soon as it noted that I was not going to bother it. Parent 2 picked up dead sticks as it walked away from the nest, tossing them back toward the nest with its bill. It did not actually carry the materials to the nest but each time threw them closer. It went to the south end of the enclosure.

11:45 a. m. Parent 2 wandered back within 4 meters of the nest and preened.

11:47 a. m. Parent 1 rose and left the nest as Parent 2 immediately sat on the eggs. Parent 1 went to the south end of the enclosure.

11:55 a. m. A Canada Goose approached within a few meters of the nest and the incubating crane rose and walked slowly toward the goose with a threatening attitude, head down and wings slightly out from body.

12:05 p. m. Parent 1 approached within 32 meters of nest, then left again.

12:25 p. m. Parent 1 back, walking on the rocks again. It walked to the nest and the other crane rose, whereupon both stood examining the eggs with their heads down. Parent 2 left. Parent 1 settled down on the eggs.

1:05 p. m. Parent 2 back within 16 meters of the nest; preened.

1:15 p. m. Parent 2 within about 3 meters of the nest. Keeper came in with food but neither bird moved. Parent 2 viciously chased several other birds. Geese, especially, were chased—Canadas, Blues, Snows, and White-fronted, beside Mallards, Black Ducks, Red Jungle Fowls, and even Starlings and English Sparrows left hurriedly.

1:23 p. m. Parent 2 went to the nest and Parent 1 left, throwing sticks back toward the nest and wandering about in the nest vicinity. It then went to where the birds were eating the mash which the keeper had thrown them, and chased all of them away, starting to eat. From here it went into the water where it flapped its wings and jumped crazily about.

1:55 p. m. Parent 1 returned to the rocky shore where it stood preening and scratching its head. It drank from the water, then waded into deeper water until this reached the feathers of the tibiae.

2:07 p. m. Parent 1 picked up a dead fish and threshed it back and forth in the water, finally threshing it into shreds, whereupon it swallowed it entire.

2:13 p. m. Parent 1 back to the nest. Parent 2 rose and moved away from the eggs as Parent 1 started incubating. Both worked with nest material.

2:20 p. m. Crane's nest was entirely in the sun for the first time today. Parent 1 incubating; Parent 2 wandering in the south end of the enclosure.

2:30 p. m. Parent 1 rose and turned the eggs, then faced west. I left the enclosure but the parent did not leave the eggs. The following table (Table 1) summarizes periods of attentiveness for August 11:

TABLE 1

ATTENTIVE PERIODS OF SARUS CRANE AT NEST, LINCOLN PARK ZOO, CHICAGO, ILLINOIS, AUGUST 11, 1946

	Parent 1		*Parent 2*	
Before				
8:20–8:40 a. m.	20+	8:45–9:35 a. m.	50	
9:35–10:14 a. m.	39	10:14–10:41 a. m.	27	
10:41–11:47 a. m.	66	11:47–a. m.–12:25 p. m.	38	
12:25–1:23 p. m.	58	1:23–2:13 p. m.	50	
2:13–after 2:30 p. m.	17+			
Eggs unattended for 5 minutes	200+		165	

Total 370 minutes.

On September 1, 1946, I again visited the Sarus Cranes at the Lincoln Park Zoological Gardens. I arrived at the enclosure before daylight. It was warm and semi-cloudy and had rained hard for a few minutes but had cleared before daylight. The following notes were taken:

5:32 a. m. Incubating Sarus Crane was sitting on the eggs with head up even in the dark. First goose called; ducks were quacking.

5:40 a. m. Rooster crowed and pigeons started cooing.

5:42 a. m. Parent 2 was found roosting in the water about 35 meters from the nest under a low everhanging branch from a near-by tree. The water was about ankle deep, and the crane started wading toward the nest but passed by it in the water, then returned but did not go on shore.

5:50 a. m. Parent 2 started feeding along shore. Parent 1 still on the nest.

5:54 a. m. Parent 2 walked out of the water to the edge of the nest. Parent 1 rose and both looked at the eggs for about 90 seconds, then Parent 1 started working with nest material for 3 minutes, so that it was 5:58 before Parent 2 walked onto the nest. When Parent 1 left the nest, it went only about 1 meter away where it stood; then it started picking up sticks with its bill and threw them in the direction of the nest, sometimes carrying them within about a meter of the nest. A Canada Goose came within about 13 meters of the nest and the crane made a dash in its direction, making it run away. Then the crane worked with a large dead branch about 6 meters away, breaking off large and small twigs, throwing them in a pile in the direction of the nest. Finally it went to the southward.

6:04 a. m. Parent 1 returned, wading in the water to the northward. The pigeons were all out on the roost now. The first African Crowned Crane [*Balearica pavonina pavonina* (Linnaeus)] called near by at 6:09—a loud, ringing *Kronk-kronk-kronk-kronk-kronk*. It called again at 6:25, 6:50 and 7:11 a. m. No other cranes called.

6:09 a. m. Parent 1 started for the feeding pen where grain was placed, and entered the small enclosure where it fed continuously until 6:25 a. m. While it was feeding, the other birds—Canada and other geese, Black Ducks, Red Jungle Fowl—moved swiftly just out of reach, waiting and watching for it to leave. When it turned in their direction, all but the Jungle Fowl dashed quickly away a few feet farther. The Jungle Fowl also was prepared to leave hurriedly.

6:25 a. m. The feeding crane walked out of the food pen and waded into the water where it started pecking at something. It suddenly raised up and jumped crazily about with wings half outspread.

6:30 a. m. The crane came out of the water to the edge of the nest. Parent 2 pecked at the nest material as it sat on the eggs. At 6:31, Parent 2 rose and left the nest, starting to peck the twigs in the vicinity of the nest, then throwing them back toward the nest. The other parent went away for a short distance and pulled several sticks closer to the nest. Parent 2 pecked at twigs and sticks until 6:40 a. m. and then started suddenly for the grain feeding pen. All of the other birds left the food swiftly again, even though the crane showed no tendency to dominate. During one minute it ate 59 kernels of grain, raising its head twice to

look around. It ate continuously and at 6:52 still ate 54 kernels of grain during one minute. It left at 6:57 after feeding for 17 minutes, and started feeding outside on some mash.

6:59 a. m. The crane jumped crazily about, flapping its wings; then went into the water for about 12 meters where it stood preening its wing and body feathers, flapping its wings occasionally. At 7:03 it called a low *Garooo*.

7:10 a. m. Parent 2 came to the nest, stopping about 4 meters away. Parent 1 rose and walked away, and Parent 2 went onto the eggs at 7:11. Parent 1 went to the large branch and started throwing twigs back toward the nest until 7:18. Then it went to the south of the enclosure, chasing a Blue Goose and several Black Ducks on the way, even wading into and out of the water to do it.

7:27 a. m. The crane was still preening as it stood in the water, and it remained there until 7:46.

7:46 a. m. Parent 2 rose as Parent 1 approached 60 meters away.

7:50 a. m. Parent 1 walked onto the nest and turned the eggs several times while Parent 2 threw sticks back toward the nest. Parent 1 incubating; Parent 2 to the south, then to the north.

8:10 a. m. Parent 2 struck at a passing butterfly but missed it.

8:18 a. m. Parent 2 went to the feed box again, feeding until 8:28; then it preened.

8:32 a. m. Parent 2 jumped crazily about in the shallow water; then at 8:38 went to the nest.

8:38 a. m. Parent 2 went to the nest; Parent 1 left, starting to throw sticks. (One crane has a lighter ear patch than the other.)

8:47 a. m. Parent 1 went to the feed box, leaving at 9 a. m. when the caretaker arrived. It walked away with head erect.

9:02 a. m. Crane went to the nest as Parent 2 went to the southward.

9:55 a. m. Parent 2 came back and Parent 1 rose from the eggs. Parent 2 started to incubate as I entered the enclosure. I went within 5 meters of the nest. Both cranes stood about 6 meters away from it. One, with wings half outspread, jumped about in the water. When I approached within 1 meter of the nest, both birds ran back onto it and stood with beaks and wings ready to attack; one had its wings half outspread. Parent 2 uttered a low guttural *Purrrr* just like that given by adult Sandhill Cranes at the nest when they call young to them or when one approaches the nest to incubate. Parent 1 began dancing about the nest and into the water with wings outspread. I did not bother them any more.

Mr. Perkins wrote me that they took the eggs from the cranes late in September. The birds had been incubating these since mid-July—a period of 70 to 72 days. On the opposite page is Table 2 giving the behavior of the Sarus Cranes at the nest on September 1.

THE YOUNG

The young are covered with a yellowish brown down when they hatch. Mrs. Belle J. Benchley wrote that they reared one by hand, leaving the other with its mother. The father died about this time. She could see no difference in the rate of growth of the two, both maturing at the same time. Fred Stark wrote that one of the young

TABLE 2

BEHAVIOR OF SARUS CRANES AT NEST, CHICAGO, ILLINOIS, SEPTEMBER 1, 1946

Incubated	*Fed*	*Preened*	*Worked with nest material*	*Other activities*
PARENT 1				
All night until 5:54 a.m.			5:54–6:01 a.m.	6:01–09 a.m.
	6:09–6:25 a.m.			6:25–31 a.m.
6:31–7:10 a.m.			7:10–7:18 a.m.	7:18–7:25 a.m.
		7:25–7:46 a.m.		7:46–7:50 a.m.
7:50–8:38 a.m.			8:38–8:45 a.m.	8:45–8:47 a.m.
	8:47–9:00 a.m.			9:00–9:02 a.m.
9:02–9:55 a.m.				
All night; 39, 48, 53 minutes	16, 13 minutes	21 minutes	7, 8, 7 minutes	29 minutes
PARENT 2				
				5:54–5:58 a.m.
5:58–6:31 a.m.			6:31–6:40 a.m.	
	6:40–6:57 a.m.			6:57–6:59 a.m.
		6:59–7:03 a.m.		7:03–7:11 a.m.
7:11–7:50 a.m.			7:50–7:52 a.m.	7:52–8:18 a.m.
	8:18–8:28 a.m.			
				8:28–8:38 a.m.
8:38–9:02 a.m.				9:02–9:55 a.m.
33, 39, 24 minutes	17, 10 minutes	4 minutes	9, 2 minutes	103 minutes

cranes raised by their birds stood ten inches taller than his 'daddy' and that all of the young became larger than their parents.

Mrs. Benchley wrote that the young remain in the nest from 24 to 48 hours after hatching, like Sandhill Cranes, and it was mentioned also by Rothschild (1930: 67–68). Rothschild further noted that the young picked up insects and worms for themselves for the first time when eight and nine days old, and that they remained with their parents until they were full-grown. At the San Antonio Zoological Park, young have been hatched four successive years. When a new nest was started the adult Sarus Cranes would not tolerate the young of the previous year in the same enclosure. Prior to that they watched over them assiduously. Mr. Stark said that the young were fed by the adults until about six months old. Rothschild (1930: 67–68) stated that the young cranes that had hatched August 19 and 20 were fully feathered by November 30 and that they began to fly December 19. Between January 30 and February 24 they began to molt their first plumage.

A young Sandhill Crane which we raised was born May 10, 1942. It began to molt August 1 and started to fly July 8, clearing the ground by 12 inches (30.5 cm.) for a short distance. It could fly about 200 feet (69 meters) by July 20 when 71 days old.

The plumage of the young bird during the first few months is brownish and, as Mrs. Benchley wrote, is scalloped in appearance, with the plumes of the down remaining on the tips of many of the feathers, especially the tertials and rectrices.

BEHAVIOR OF ADULTS

When adult Sarus Cranes become mated they remain together as long as both are alive. Colonel Ticknell (Blyth and Tegetmeier, 1881: 50) stated: "Such, indeed, is the affection and constancy of these noble birds to each other, as well as towards their young, that throughout India it is considered by both Hindoos and Mahomedans almost a crime to destroy them; and, indeed, I doubt whether an English sportsman, even of the most unsentimental kind, after killing one of a pair, or of the little family group, would have the heart ever to repeat the experiment, so grievous are the cries raised by the unhappy survivors." Hume and Marshall (Blaauw, 1897: 26) stated that if one bird of a pair was accidentally killed, the other bird died almost immediately, evidently by starvation. The natives of India also claimed this to be the case.

Usually the pairs of Sarus Cranes are found feeding in the wild in open fields, and if approached too closely, fly a short distance to another field. They have a dance similar to that of other cranes. In the Detroit Zoo on two occasions, I watched a pair perform quite a dance. They started by facing each other, then bowed and raised their heads, repeating this several times. Finally one or both jumped into the air with wings half outspread.

Sarus Cranes are strongly territorial, even in respect to other Cranes. The male of a pair kept in the San Diego Zoo tried repeatedly to attack a male Manchurian Crane in a neighboring enclosure (Mrs. Belle Benchley, letter), and finally went over a seven-foot fence, almost killing the Manchurian Crane. When the two young hatched, he again tried to attack this male and fractured both of his mandibles, dying a few days later from starvation and loss of blood.

Similarly they attack the young Sarus Cranes when they are ready to nest the following year, according to Fred Stark of the San Antonio Zoo. One of the two young raised by hand in the San Diego Zoo, when returned to the enclosure where the mother and other young were kept, after the young were full-grown, was immediately attacked by the mother and the other youngster. It was necessary to remove it from the enclosure. Similar behavior was noted in the New York Zoological Park with a male Wattled Crane when a new female was introduced. Finally, the female was placed in an adjoining pen and

even then the better part of a year passed before the two birds would tolerate each other (Crandall, 1944: 126).

The Sarus Crane evidently prefers to nest in an enclosure where other cranes are not present and where there is some water as well as a place to hunt for insects.

VOICE

The call of the Sarus Crane, like that of other cranes, is very loud—a penetrating trumpet, shriller than that of the Sandhill Cranes. Two cranes in the Detroit Zoological Park have been heard calling on numerous occasions, often in unison. Usually when two cranes call this way, one is shriller than the other, as was the case with these Detroit cranes. Standing side by side with bills pointed toward the the sky, they uttered the loud *Gar-ooo-o-o-a—gar-ooo-o-o-a—gar-ooo-o-o-a*, often repeating it several times.

A call of one adult, given when approaching another at the nest, was a low, barely audible *Purrrr*. This same call is given in similar circumstances by Sandhill Cranes which also use it to call the young to them. On many occasions I have called the young Sandhill Cranes from hiding in sedges and grasses by giving this call.

The young Sarus Crane, according to Blyth and Tegetmeier (1881: 50), has a querulous, whistling note, a kind of long trill, which is constantly repeated when they are expecting food. Fred Stark of the San Antonio Zoological Society gave the call of the two-months-old crane as between a chicken-like *peep* and a whistle. This call was given until the young were about ten months old when they began to call like the adult.

I have heard the young of the Sandhill Crane give the *peeeep* or *peeeer* call even into the following April. The bird that we raised, hatched on May 10, 1942, started giving the adult call when ten months old, the middle of March, 1943.

OTHER NESTINGS

There are many records of certain cranes breeding in captivity. Blyth and Tegetmeier (1881: 6) record the Manchurian Crane [*Grus japonensis* (P. L. S. Müller)] nesting at the Zoological Gardens in Regents Park as described in 1861 by Bartlett. Blaauw (1897: 12) stated that the Manchurian Crane nested commonly in captivity and that a pair hatched two young during 1892, thirty and thirty-one days after the eggs were laid.

The White-necked Crane (*Grus vipio* Pallas) has bred many times in captivity. Blaauw (1897: 50) stated that it had bred repeatedly in the Zoological Garden of Amsterdam and that incubation lasted 30

days. In the United States it has bred in the New York Zoological Park where one young was raised in 1916 and another in 1943 (Crandall, 1944: 125). Kieth Kreag (1946) described the nesting of the species in the Detroit Zoo in 1946 when they raised a single young. Another record, from Germany, by Hagenbeck (1940: 348–354) discusses a pair brought from Japan in 1933 which hatched in 30 days, two young in 1933, one each year in 1935, 1936 and 1937, four in 1938 (two killed by hail), and two in 1939.

Blaauw (1897: 24) stated that the Sandhill Crane often bred in captivity but that as yet they had not reared any young. They have bred also in the New York Zoological Park (Crandall, 1944: 125). Jean Delacour (verbal) had several members of the genus *Grus*, including *canadensis*, nest in captivity at Clères, France. Frank W. Robl (letter) had a pair of *Grus canadensis* breed in semicaptive conditions at Ellinwood, Kansas, hatching a young July 12, 1939, when the thermometer registered 112° F. The young died before the first night. Sibley (letter) has written that *Grus canadensis* has raised young in captivity for him in Connecticut.

The Wattled Crane (*Bugeranus carunculatus* Gmelin) has nested during 1944, 1945 (Crandall, 1944: 125–127; 1945: 119) and during 1946 at the New York Zoological Park. They raised one young during 1945.

Demoiselles (*Anthropoides virgo* Linnaeus) and Stanley Cranes (*Anthropoides paradisea* Lichtenstein) have both bred in the New York Zoological Park (Crandall, 1944: 124). The Stanley Crane has nested at the Detroit Zoo (Theodor Schroder) but did not raise any young; also at the San Diego Zoo (Mrs. Benchley). Stanley Cranes did raise one young at the Brookfield Zoo, Chicago, in 1943 (Karl Plath, 1943: 383–385).

O. A. Maine (The Providence, Rhode Island, Evening Bulletin, August 26, 1938) described a pair of African Crowned Cranes (*Balearica pavonina*) nesting at Roger Williams Park, which hatched three young 29 days after the eggs were laid.

Summary

The Sarus Crane has bred in captivity in recent years in three zoological parks in the United States: San Antonio, Texas; San Diego, California; and Chicago, Illinois. Young were reared during three years and hatched a fourth year in San Antonio; in San Diego, young were reared one year; in Chicago, eggs were laid five years but none hatched, since both birds evidently were females.

Nests were built on dry ground but near to water where available. Materials at hand were used in the construction. Eggs were laid from

late June until September, usually July and August. Two eggs were laid as a rule, but one nest in Chicago (probably two females) contained as many as five eggs. The eggs are white sparsely spotted with brownish and are similar in size to the eggs of the Greater Sandhill Crane. Both parents incubate.

Incubation requires approximately 32 days. Young are covered with yellowish brown down at hatching and remain with the parents until the following summer, but when the parents are ready to nest again they will not tolerate the young of the previous year in the same enclosure.

The young are able to fly when four months of age.

Records are now available of the nesting of each genus of cranes in captivity, showing that if conditions are proper, probably any crane will breed in captivity.

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Battle Creek
Michigan

GENERAL NOTES

The roosting tree of the Scissor-tailed Flycatcher.—Knowledge of the flocking and social behavior of the Scissor-tail (*Muscivora forficata*) is inadequate. In 'Life Histories of North American Flycatchers, Larks, Swallows, and their Allies' (U. S. Nat. Mus., Bull. 179: 82–92, 1942) Bent quotes Mrs. Florence Merriam Bailey on an observation of communal roosting by these birds in Texas. Her article (Condor, 4: 30–31, 1902) relates that "when Mr. Bailey shot a rattlesnake at the foot of a big oak in camp the report was followed by a roar and rattle in the top of the tree and a great flock of scissortails arose and dispersed in the darkness." She attributed this concentration to a general lack of suitable roosting places in the area between Corpus Christi and Brownsville.

One of the least known facts of this relatively well known bird is the post-breeding season behavior. Its individuality during the breeding season is well known, when audacious attacks on larger birds are commonplace and even vigorous defense of a territory against members of its own species is the rule. But the interesting contrast comes after the ties of territoriality have been broken and the juveniles have attained nearly full growth. This extreme is a very decided flocking or gregarious tendency at roosting time, which is seemingly peculiar to this species in the family Tyrannidae.

During the summer of 1946, ample opportunity was afforded for the observation of these birds in and around College Station, Texas, which lies in the center of the breeding range. The flocking behavior was first noticed on the campus of Texas A. and M. College about 6:30 P. M. on August 23, when a large number of Scissor-tails were seen in and around one large tree, an osage orange (*Maclura pomifera*). In spite of the availability of dozens of other trees that appeared to be equally suitable as roosting sites, this one tree was selected and used night after night until mid-September when migration had thinned their ranks. Birds were followed from as far as one and one-half miles away to the tree, indicating that this roost served an area at least three miles in diameter. The birds were easy to alarm just before dusk and when frightened arose with a roar of wings and dispersed in all directions. What motivates this aggregation, and what sort of social organization makes it function so systematically would make an interesting study.—Frank W. Fitch, Jr., *Texas A. and M. College, Fish and Game Department, College Station, Texas.*

January singing in the Black-capped Chickadee.—The experience of Mr. Aretas A. Saunders with the singing of the Black-capped Chickadee (*Parus atricapillus atricapillus*) in southwestern Connecticut as shown in his paper 'The Seasons of Bird Song: The Beginning of Song in the Spring' in The Auk for January, 1947, differs so decidedly from my own in eastern Massachusetts that it seems worth while to put mine on record. I agree with Mr. Saunders and most other observers in considering the *phoebe* whistle to be a song, and it is of that note that we are speaking.

Mr. Saunders says: "I have heard it every month of the year except January. The earliest date on which it was heard averages, in thirty-two years of observation, March 13. The earliest date is February 5, 1938, and the latest, April 19, 1935." My own records go back much farther than his, but for purposes of comparison I will use only those from 1915 to 1946, inclusive—thirty-two years. I have heard the Chickadee's song in January in seventeen of those thirty-two years, and in five of those Januaries I have heard it on four to six days. My average earliest date is February 4 as against his March 13. My earliest date of all is January 1 in 1926,

and my latest April 11 in 1915. In the present year of 1947, not included in the foregoing summary, I heard the song on four days in January—the 19th, 13th, 25th, and 28th. It occurs to me that perhaps my early records of Chickadee song may be due to the fact that the Chickadee, especially since winter feeding began, is a pretty constant inhabitant of my immediate neighborhood in winter and spring. I find that my records for the only two years that show April dates for the earliest song also show comparatively few records of the presence of the bird about my house. In 1915, when the first singing was noted April 11, I recorded the bird as present with us only January 4, 10, 17, 24; February 27, 28; March 13, 21, 24; and on April dates before the 11th. In 1921, when the first singing was noted April 6, the only Chickadees recorded about the house were on January 1, 16; February 13; and March 16 and 21. The omission of these two aberrant years from my summary would bring my average back into January, the month when Mr. Saunders has never heard the song—to January 31, to be precise.

I am puzzled to account for this difference between Mr. Saunders's experience with Chickadee song and mine, and on writing to him about it I find that he too is unable to account for it satisfactorily. He writes me under date of February 20, 1947: "At least part of the discrepancy between your experiences and mine is due to my not living among Chickadees most of the time. From 1919 to 1939 I lived in a place where Chickadees were almost never seen, so my observations were largely confined to field trips which were mainly week-ends. But since the fall of 1939 I have lived practically in the woods, and have fed Chickadees every winter. They were scarce some winters, but in others I recorded them almost daily each January yet never heard the song. This year I beat my earliest record by hearing one February 3, but still that wasn't January."

It would be interesting to learn of the experience of other observers with this common bird whose song seasons do not follow conventional patterns.—Francis H. Allen, *West Roxbury, Massachusetts.*

Post-nuptial copulation among swallows.—While I was watching a large number of migrating swallows swarming over the Fern Ridge Reservoir west of Eugene, Oregon, on August 31, 1946, a copulation act was observed between a female Violet-green Swallow (*Tachycineta thalassina lepida*) and a male Barn Swallow (*Hirundo rustica erythrogaster*).

Numerous swallows of both of these species and two others were alighting along the water's edge from six to twenty feet from the car in which I was sitting. While I was watching these birds, I noticed a female Violet-green Swallow alight and not settle down as the other birds were doing. Rather she fluttered her wings and rocked her body. Very shortly afterwards a finely marked male Barn Swallow dropped onto her back, performed copulation, flew off a few feet and returned to repeat a second time. After the second action, both birds flew away and disappeared into the swarming flock. Having observed the nesting and habits related to nesting of the Violet-green Swallows for several years, I had no doubt as to the action anticipated by the female, nor was there the least doubt concerning the species performing the action.—Gordon W. Gullion, *1657 E. 13th St., Eugene, Oregon.*

Behavior of nestling Tree Swallows in water.—The following event took place while I was banding young Tree Swallows (*Iridoprocne bicolor*) at Douglas Lake, Cheboygan County, Michigan, on July 29, 1946. I had just banded and returned to the nest (in a swallow house on a five-foot post about five feet from the water's edge) the last of a family of five fledglings and was continuing my daily

inspection of the 20 similar houses, when one of the young birds just banded flew out of the box on its maiden flight and headed directly out over the lake. I watched it travel approximately 75 yards and then drop to the water exhausted. Hastily peeling off my clothes, I swam after it. I found the bird apparently quite unperturbed and making rather rapid headway *in the direction of the nearest shore* with flipper-like movements of its wings. It swam with its tail sticking straight up in the air, Ruddy Duck fashion, and made rather concerted struggles to prevent me from capturing it. I carried it back and returned it to the nest where it stayed. The other four young birds were still there.

Two days later, a similar exhibition took place at another nest. This time the bird, in flight and out of the nesting box for the first time, crash-landed about 30 yards from shore. I watched it swim all the way in this time—again by the most direct route. Though somewhat bedraggled, it was quite able, on reaching shore, to stand on its feet and make headway up the beach away from me. This bird also was returned to the nest and remained there until the following morning.—Robert O. Beatty *Izaak Walton League of America, Inc., Chicago, Illinois.*

Nest-building by the Virginia Rail.—Although there is excellent printed material on the nesting of the Virginia Rail (*Rallus limicola*), eye-witness accounts of the actual nest-building appear to be few. The following notes, made from observations in a small cattail marsh not more than two miles southeast of the business district of Pittsfield, Massachusetts, may therefore be of interest.

Here Pied-billed Grebes, Florida Gallinules, Soras and Virginia Rails had been seen and heard frequently during the spring and summer of 1946. On July 8 I had been hearing both species of rails give the usual calls, with the addition of some loud *pip-pips* uttered by a Virginia Rail as it fed near by. At 7:30 P. M., while I was sitting at the edge of the marsh where a four-foot bank gave excellent view over the lower land, a Virginia Rail came close by with a piece of cattail (*Typhus latifolia*) in its blood-red bill. It went at once to a small 'island' in the shallow water, a spot not more than six by twelve inches in extent which was covered with grass, a species of bedstraw (*Galium* sp. ?) and a clump of Marsh Fern (*Thelyptris Thelypteris*). The rail dropped the material, worked it in with her bill—I am assuming the bird to have been a female—and then sat down, turning around and molding the nest site.

As I sat a fascinated spectator about twelve feet away, and only partly concealed by bushes, the bird worked busily for an hour. Hurrying away from the nesting site, she tugged vainly at a piece of dead cattail, not seeming able to cut it off with her bill. She tried two others before succeeding in getting a 'mouthful' which was again worked into the nest without loss of time. After a number of such trips, gathering bits of cattail from three to fifteen inches in length, about half of which were dry and the others wet and mucky, the bird spent ten minutes at the nest. She scratched around the bottom with bill and feet, next turned completely around several times, and finally, still sitting, reached up with that useful, long bill and cut off pieces of grass and bedstraw. She dropped these into the nest, and then adjusted the scanty foliage, picking here and there to make it conceal her to better advantage.

The bird worked steadily, moving to and from the nest rapidly, without a pause in her nest-building labors. If my eye momentarily wandered, suddenly the bird was not there, and it took careful watching to detect her approach to the nest. Once her mate (I supposed) called *wak-wak-wak* close by, whereupon I saw and heard her give a peculiar high *wa-a-ak* four times, much higher and more squeaky than the usual calls. As darkness fell, I left, sorry that further observation and photography were impossible, since this was my last day in Berkshire County for some months.—Dorothy E. Snyder, *The Berkshire Museum, Pittsfield, Massachusetts.*

An impeded Herring Gull.—On the morning of January 26, 1947, Mr. Irwin Alperin, Mr. Walter Sedwitz, and myself were looking over a flock of mixed Herring, Ring-billed and Black-backed Gulls, numbering about one hundred and fifty birds, at Breezy Point, Long Island. We observed an adult Herring Gull flying toward us, with a string about fifteen feet long trailing behind it. This was apparently caught on its foot and strung out in a plane parallel with its body. A piece of wood, unpainted, irregularly rectangular in shape, and approximately eight by five inches in size hung from the string about four feet from the end of the bird's tail. There was nothing about the bird's flight or behavior denoting particular alarm as would be analagous to a frightened dog with a can tied to its tail, but when this bird flew over the flock of gulls we had been observing, they immediately flushed up, and then returned as the gull disappeared. The fact that a member of their own genus, so disposed, released a fear response in the resting birds seems curious enough to record as a note and perhaps be of significance to some investigator.—Dr. M. A. Jacobson, *New York, N. Y.*

A concentration of Bald Eagles in Virginia.—On the morning of September 10, 1940, Dr. Edward Fleisher, Mr. Irwin Alperin and myself witnessed an unusual Bald Eagle concentration from the Cape Charles ferry as we were docking at Little Creek, Virginia. On previous occasions Dr. Fleisher and I observed one or two birds at this locale. This time we had a minimum count of twenty-three. They were sitting on the beaches, flying, and perched in trees, much like a flock of vultures. Never having seen such a large number of eagles previously, we were indeed strongly impressed, but what was still most curious, every bird we saw was immature! What prompted this grouping of young birds, at this particular time and locale, in such numbers, is just another unanswerable question we submitted to our very long list concerning the avifauna.—Dr. M. A. Jacobson, *New York, N. Y.*

Wing-flapping rates of birds.—It is surprising, in view of the important part played by wing flapping in the flight of birds, that there should be so few reports of rates of flapping. In the past few months I have accumulated a certain amount of data by counting flaps over a period measured with a fifth-second stop watch. The method in my hands seems satisfactory up to seven or eight flaps per second and is not feasible for small birds.

In the observations which follow, it is to be understood that the bird was in established flight, unhurried, and at apparently constant speed unless otherwise stated. When given, the variation is the standard deviation, not the probable error.

Double-crested Cormorant.—2.6 ± 0.35 complete strokes per second; 7 observations.

Black Duck.—2.0 per second; 3 observations. This seems a very slow wing rate. More data are needed.

Sparrow Hawk.—2.4 per second; 1 observation.

Ring-necked Pheasant.—3.2 per second; 1 observation. Taken near the middle of a flight.

Killdeer.—2.4 per second; 3 observations.

Great Black-backed Gull.—2.0 per second; 1 observation.

Herring-Gull.—2.3 ± 0.3 per second; 37 observations.

That a bird may stroke very uniformly under constant conditions is shown by five successive observations on a single bird which yielded 2.2, 2.3, 2.3, 2.3, 2.3 strokes per second, which give an average of 2.3 ± 0.05. The error inherent in the stop watch averages 0.09 strokes per second, and the rate of the bird may be regarded as uniform.

LAUGHING GULL.—2.45 per second; 2 observations.

DOMESTIC PIGEON.—3.0 ± 0.47 per second; 15 observations. In this species the rate is quite variable and more data are needed to determine the dependence of rate on the conditions of the flight.

MOURNING DOVE.—2.45 per second; 2 observations. Both of these observations were taken from long, straight flights. In this species, short glides, each occupying about the time of one stroke, are irregularly interspersed.

BELTED KINGFISHER.—2.4 per second; 2 observations. This is an overall rate including the glides inserted between each two or three strokes.

NORTHERN FLICKER.—2.2 per second; 1 observation of the characteristic flap and glide flight.

BLUE JAY.—In this species I have been able to classify partially the various types of flight and give the results for three of them:

The first few strokes after take-off—4.0 ± 1.1 per second; 7 observations.

Steady flapping flight—2.6 ± 0.24 per second; 20 observations and 3.4 ± 0.28 per second; 18 observations. The array of observations is clearly bimodal but the cause is not yet known. This style of flight is used when flying against the wind or when gaining altitude.

Flap and glide flight—2.2 ± 0.27 per second; 35 observations. When slowly losing altitude, this is the normal style. It is not as evenly undulatory as in the Flicker but shows a slow descent and a sharp rise with the stroke.

AMERICAN CROW.—2.0 ± 0.31 per second; 17 observations. The flight of the Crow should be divided into styles similar to those of the Blue Jay. My data are still insufficient for this purpose.

EASTERN ROBIN.—2.3 ± 0.2 per second; 5 observations.

EASTERN BLUEBIRD.—3.1 per second; 2 observations.

STARLING.—3.3 per second; 3 observations. These are for the usual flight of three strokes and a glide. The species shows other styles of flight.

EASTERN GOLDFINCH.—4.9 per second; 1 observation. The glides are included and three strokes are counted between each glide.

It would appear that the flapping rate depends on: (1) the style of flight, (2) the size and shape of the wing, (3) the rate of motion of the center of pressure of the wing, (4) the ground speed, (5) air motion.

The first point is obvious and is illustrated well by the figures given for the Blue Jay. The second point is equivalent to saying that the rate depends on the total power which the flight muscles put out in overcoming the resistance of the air to wing motion.

The third point rests on the hypothesis that some minimum velocity of the center of pressure is necessary to maintain flight whether the type be flapping or soaring.

The fourth and fifth points are, in some respects, connected. Both rest on the view that the bird as a sentient organism is aware of its goal when flying. This teleological view is easily justified by observation. The detail in which the goal is envisioned at any given moment will evidently depend on circumstances of time, distance, and visibility. However, a bird flying by day toward a reasonably near and familiar goal does not fly in a random fashion. It takes account of the relative altitude of starting point and goal and of the rate at which it should approach the goal. Local variation of air motion will cause a bird to alter its style of flight to maintain as nearly as may be its speed and direction.—CHARLES H. BLAKE, *Massachusetts Institute of Technology, Cambridge, Massachusetts.*

Wood Ducks versus squirrels.—Much is written regarding the interrelations between competitive species, but field observations of the actual contacts between individuals of these species are rare. I live in a wooded tract on the Mississippi bank, five miles north of Minneapolis. For the past five years one or two pairs of Wood Ducks have nested in hollow basswoods within easy observing distance of our windows. Here we have had excellent opportunities to watch the activities of the ducks around the nest cavities during the early part of the nesting season, before the leaves have fully grown. On March 20, 1946, while eating breakfast, I noticed a female Wood Duck alight in the old nesting tree, and a moment later the male settled in a near-by tree. They were obviously exploring for a possible nest site. A red squirrel in the tree near the female seemed irritated by their presence and immediately ran to the limb on which she was perched and dashed out toward her with all the confidence in the world. I had no doubt that the duck would fly, but to my surprise it did not; in fact, it sat calmly awaiting the onrushing squirrel, whose attack proved to be largely bluff. The squirrel, nonplused by her refusal to budge, stopped short a few feet away and, backing up, rushed at the duck a second and a third time with no better success. Then the squirrel changed its tactics, and slipping around underneath the three-inch limb, it attempted to attack the duck from beneath. Each time the squirrel showed its head around the limb, however, it was met by a determined peck from the duck and in a few moments the squirrel gave up, leaving the Wood Duck complete master of the situation. The squirrel then went directly to the tree in which the male was perched on a ten-inch horizontal limb. Here it attempted to dislodge the male with exactly the same type of attack, but met the same resistance and retired without in the least disturbing the ducks. Neither did the red squirrel's presence deter them from nesting, for a few days later the duck began laying in the old nest cavity and, perhaps aided by a second female, deposited twenty-five eggs of which nineteen appeared to hatch successfully.—W. J. Breckenridge, *Minnesota Museum of Natural History, University of Minnesota.*

Rôle of male Yellow-bellied Sapsucker in the care of the young.—Observations made at the nest site of a pair of Yellow-bellied Sapsuckers (*Sphyrapicus varius*) revealed some unusual types of behavior as well as a daylight attempt at predation by a weasel. Although, from one viewpoint, the record appears to give data on two different organisms, the resulting behavior of each in the situation described will be of interest to many. Therefore, it seems wise to report the story in detail.

The loud noise of the young of this bird often, as in this case, discloses the location of the nest hole. This one was situated in a dead sugar maple standing in an old sap orchard in central New York State. The nest hole was about thirty feet above the ground. There on June 24, 1945, when the study began, the young birds were estimated to be about half-grown. Detailed notes of the behavior of the adults were made on that date for one and one-half hours in the middle of the day and again on June 26 and 27, from 7:00 P. M. on the 26th, continuously through the night until 7:00 A. M. June 27. The most interesting findings of this study might be classified in three parts as follows: (1) Feeding behavior; (2) adult reactions and duties of the birds; (3) weasel predation.

Feeding Behavior

During a ninety-two-minute period on June 24 the male fed seventeen times, never spending more than two minutes in the nest hole. During the same period the female fed eleven times, spending shorter periods at the nest than the male. Of the ninety-two minutes, the male spent fifteen inside the nest hole, the female eight and one-half minutes.

On June 26, during the two hours of feeding in the evening, the male fed seventeen times, the female six times. In the early morning, between 5:05 A. M. and 7:00 A. M. the male fed eighteen times, the female once. Feeding ceased at 9:00 P. M. and began in the morning, at 5:27 on June 27. During the last one and one-half hours of observation on June 27, the female was absent from the immediate territory and did not feed the young until 6:58 A. M. although she had reported at the nest site at 5:05 A. M. when the male flew out from roosting.

Adult Duties

The male did all the nest cleaning. Frequently he would emerge from the nest hole after feeding, with a beak full of fecal material and wood chippings resembling sawdust. This material was always (so far as these observations record) taken to a specific location on another tree about forty feet from the nest hole—a location that might be described as an old healed-over knot with rough bark protruding. This tree is known in my notes as the 'cleaning tree.' The male repeatedly carried the waste from the nest to this old knot on the 'cleaning tree' at which point he dropped the material and cleaned his beak by wiping it several times on the rough bark around the knot. Following the act of cleaning his beak, he sometimes went up or down the tree a few feet before leaving in search of food among the surrounding trees. At the base of the 'cleaning tree' I collected a quantity of the fecal masses for study of the insect fragments. The female never cleaned the nest but occasionally she visited the knot on the 'cleaning tree' and inspected some fragments of the cleanings adhering there.

The male roosted in the nest hole at night. He appeared to be just inside the hole looking outward rather than hovering the young. This manner of roosting effectively shut off the sound of the noisy young. Whereas the young had been emitting a continuous chatter during the day, they became quiet at roosting time and did not make any appreciable amount of noise until after feeding was resumed the next day.

Weasel Climbs the Nest Tree

Repeated attempts of a weasel to climb to the nest hole were thwarted only because of the absence of bark on the dead nest tree for a distance of three feet below the nest. The weasel could not climb this barkless portion of the tree trunk. The notes quoted below were taken at the time from a position on the ground about 20 feet from the nest tree.

"7:20 P. M.—The male bird came to the nest tree calling excitedly and immediately went into the nest hole, quickly reversed, facing outward, calling. The female was on hand at once, flying about excitedly. Then I noticed a weasel at the base of the nest tree, starting to climb. It climbed easily up to the barkless area. Meanwhile both birds flew at the intruder, the male bird actually striking the weasel with the beak, finally knocking it free from the tree. The weasel after the fall immediately climbed the tree again in spite of renewed attacks. This time it went up the smaller of the two branches of the tree trunk to the barkless area where it attempted to cross over the intervening space toward the nest hole in the opposite fork of the tree trunk. A crossing required a jump of about thirty inches which the animal did not attempt. Under severe attack it retreated to the crotch between the two forks of the trunk. After two minutes of uncertainty it tried again to go directly to the nest hole but could go only as far as the bark of the tree provided it with a toe hold. Then it came down, circled the base of the tree and went directly to the 'cleaning tree' 40 feet away. After smelling over the nest cleanings on the ground

it climbed up 30 feet to the first branch and then to the knot where the male bird had been cleaning his bill. The fragments adhering to the bark around this knot were examined thoroughly before the weasel started back down the tree. The birds continued to attack and did again knock the animal loose from the tree when it was 20 feet from the ground. These falls did not disturb the weasel. Back on the ground it spent two minutes smelling the bird droppings at the base of the 'cleaning tree' before leaving the neighborhood in the direction of a pine thicket.

"After a period of quiet and normal feeding at 8:08 P. M. the male bird was cleaning his bill at the 'cleaning tree' when the weasel suddenly returned. I heard it on the ground passing near me. When I turned my head it stopped and tried to smell me but I remained quiet and it soon turned its attention in the direction of the noisy young birds in the nest tree. This time the weasel went up another tree—one close to the nest tree. The male bird again attacked, and the weasel started down the tree head first in the manner of a squirrel. When about fifteen feet from the ground the bird again dislodged the animal and caused it to fall. After this it circled the base of the nest tree but did not try to climb again. Soon it left the neighborhood in the same direction as before."

It seems likely from this record that the weasel had visited the birds before the first recording by this observer. Its ability to climb and its persistence in the attempt to get to the nest during these daylight hours may be an indication of what happens to many hole-nesting birds during the dark hours as well as in daylight. The author is of the opinion that we need many more observations of what is going on in the bird world during the twilight hours and during the nights.—R. A. Johnson, 98 *East St., Oneonta, New York.*

Flight speed of Wild Turkeys.—While conducting a Wild Turkey investigation in West Virginia, the author has had several opportunities to check accurately the flight speed of these large game birds. On September 11, 1946, a large gobbler was flushed by the car from a mountain road. The gobbler took a few running steps and, with several heavy, powerful strokes of his wings, was soon in the air. For about 50 to 60 yards the bird flew with a rapid and strong wing beat. He then set his wings and sailed for a short distance following this by another series of rapid wing beats. This intermittent wing beat of turkeys in flight has been observed many times by the writer. The gobbler flew directly down the road and was followed closely by the car. A flight speed of 38 to 42 miles per hour was recorded for a distance of approximately one-half mile. The turkey finally veered sharply to the left and sailed out over the forested valley.

Again on October 21, 1946, the writer flushed a flock of 8 to 10 Wild Turkeys from a ridge. In this instance the birds flew close together like a covey of quail and landed on a beech flat below. They flew the entire distance through the forest and it was wonderful to observe their dexterity in flying through the trees. The distance flown was 722 feet in 17 seconds giving an average flight speed of 29 miles per hour. A similar observation was made on December 5, 1946, when three turkeys (one hen and two gobblers) were flushed along a road. Their flight speed for a short distance was checked with the speedometer of the car and found to be around 32 miles per hour. On December 11, 1946, a small flock of three turkeys was flushed along a forest trail. Their flight speed for 370 feet was about 36 miles per hour. Mr. Henry Perkins, resident game manager of Cranberry Game Breeding Area, reported checking the flight speed of a young gobbler with his car on October 10, 1946, when he found the speed to be approximately 32 miles per hour.

These five instances are not comprehensive but do give an indication to the range

of flight speed. The large size of the Wild Turkey often deceives the observer who attempts to estimate the flight speed. Actually the Wild Turkey may be compared to the large airplane which must have considerable wing area and fly fast to provide the necessary lift for the heavy body.—Fred A. Glover, *West Virginia Conservation Commission, Elkins, West Virginia.*

Interrelations of House Wren and Bewick's Wren.—The impression has prevailed among ornithologists that House Wrens (*Troglodytes aëdon*) and Bewick's Wrens (*Thryomanes bewickii*) do not ordinarily occupy successfully the same territories. Many observations have been to the effect that when House Wrens enter a territory as invaders the Bewick's Wrens become scarce, or move out entirely.

These observations are certainly correct during the early years following House Wren invasion of Bewick Wren territory. There is every evidence of the incompatibility of the two species, and the latter species is almost invariably the sufferer. In recent years, however, I have seen in a number of situations Bewick's Wrens reestablishing themselves in territory from which they had formerly disappeared. The result has been that both species now breed in the same areas, with seeming compatibility.

At French Creek, Upshur County, West Virginia, Bewick's Wrens were, for many years, abundant, whereas House Wrens were virtually unknown in the region until the early years of the present century. With the invasion of the latter species, however, Bewick's Wrens moved out, virtually disappearing for several years. During recent seasons Bewick's Wrens have reappeared, occupying many of their former nesting niches.

In the valley of the Ohio River (in West Virginia, at least) House Wrens for many years seemed to dominate on the flood plain, with Bewick's Wrens appearing on the escarpments back from the river. As late as ten years ago, Haller, in a study of the birds of four river-valley counties, found that this situation obtained. Within the last decade, however, Bewick's Wrens have moved down on the flood plain, and are now rather common co-occupants with the House Wrens. Burt L. Monroe, of Anchorage, Kentucky, tells me that the wren populations of Kentucky's Ohio Valley counties have had a similar history.

Near my home in Morgantown, West Virginia, a single pair of Bewick's Wrens has occupied an old shed each nesting season for the last six years. There are no other resident Bewick's Wrens near by. Surrounding this territory are dozens of nesting pairs of House Wrens. Despite the abundance of the latter birds, the Bewick's Wrens completely dominate the territory around their chosen home, and I have not witnessed any conflicts between the two species.

Since the clearing of the Appalachian forests, there have been many invasions by bird species formerly absent from the region. These invasions, in most cases at least, have followed the same pattern. First the invader appears as a pioneer; then it becomes locally common and often dominant in certain areas, frequently to the seeming detriment of some other species; and finally it settles down as an accepted member of the community, often considerably reduced in numbers. In this last stage it tolerates, and is tolerated by, other avian neighbors. I believe that Bewick's Wrens as old residents of the West Virginia hill country and House Wrens as recent invaders are now engaged in working out some such *modus vivendi*.—Maurice Brooks, *West Virginia University, Morgantown, West Virginia.*

Bank Swallow and Belted Kingfisher nest in man-made niche.—On June 9, 1946, James L. Edwards, Richard S. Thorsell, and the writer discovered a nesting

colony of Bank Swallows at the Mt. Hope Mine property of the Warren Foundry and Pipe Corporation at Wharton, New Jersey. The swallows had run their tunnels into the sides of a huge pile of iron ore 'tailings.' This scrap pile, accumulated over a period of years and now abandoned, has settled and weathered in such a way that the outside presents a large number of vertical faces. The consistency of the material is that of a mixture of coarse sand and finely crushed cinders, and is easily worked by the swallows. On a subsequent trip to band this colony, the writer also found a pair of kingfishers using the same niche. Mr. Harry Davenport, superintendent of the mine, who kindly granted me permission to band the swallows and who has rigidly protected the colony, tells me that the birds started nesting on the property in 1943. A. C. Bent, in Bulletin 179 of the United States National Museum, records two instances of the Bank Swallow nesting in piles of sawdust accumulated during lumbering operations.—HOBART M. VAN DEUSEN, *American Museum of Natural History, New York City.*

Late nesting of the Hermit Thrush in New York.—In 1944, while I was on summer duty with the U. S. Fish and Wildlife Service and living in a house at the north end of the sixteen-acre reservation of the U. S. Fur Animal Experiment Station, Saratoga, New York, I found a very late nest of the Hermit Thrush (*Hylocichla guttata*). The reservation is situated a few miles north of Saratoga Springs and can be regarded as in the outskirts of the Adirondacks. The climate is cool and the summer season is of short duration. One brood is probably the rule for the woodland passerine birds.

The reservation fronted on a larger wooded tract that, while chiefly made up of small growth, had, like the north end of the reservation, a scattering of large trees, mostly white pine, sugar maple and beech. A Great Horned Owl had a favorite hooting perch in a large white pine near the house and could be heard in the early morning hours until it began to grow faintly light. And several times a Barred Owl, a little farther back toward the main forest, would add his higher, more vociferous comments to the listener in the dark.

During June and early July, Hermit Thrushes were heard singing regularly in the woods back of the house and in a woodlot across the highway in front, with the singing gradually tapering off until by mid-July it had stopped for the season. Wood Thrushes likewise ceased to sing regularly at about the same time, though during the middle of July one Wood Thrush could be heard occasionally, carrying on a few days beyond the Hermits.

It was distinctly surprising to hear a Hermit again in good song after August was well started. Rather by accident the nest was discovered the third week of August. It was situated in a rather open place in the woods and contained only three eggs. As the fourth week of August started, two newly hatched young were found in the nest. The thid egg did not hatch and later disappeared. Then the evening of August 31, a last hurried observation was made before leaving the region. One young bird, only, was seen but it seemed to be in good condition and just starting to feather.

No observations were made on the feeding of the young, but some years earlier, in the Catskills, a Hermit Thrush was watched returning to the nest with food. The young were at the stage where they were just beginning to show feathers. Several times a caterpillar, apparently a geometrid larva, would be brought in the bill and fed after a short halt at the edge of the nest. Then a pause of some seconds would result in the regurgitation of an entire blueberry and several times the first one was followed some seconds later by a second berry. Then, if no nest sanitation was

called for, the parent would depart.—THOMAS SMYTH, *Dept. of Biology, University of Florida, Gainesville, Florida.*

Female Cowbird dead at Prothonotary Warbler's nest.—On May 22, 1941, in a little swampy woods on the south shore of the Grand Reservoir (Lake St. Marys) in Mercer County, Ohio, I noticed a dead female Cowbird lodged in a cavity entrance in a small willow stub, standing in water. As Prothonotary Warblers have nested in cavities of trees in this locality for years, I assumed that this female had intended to deposit an egg in the Prothonotary's nest but had become lodged in the entrance and had died trying to extricate herself. After removing the body, I found that the nest held one typical egg of the Prothonotary. Upon opening the abdomen of the Cowbird, I found an egg that appeared to be perfect. The Cowbird was badly decomposed. I was surprised at the force required to dislodge it from the cavity entrance. The primary feathers seemed to act like the barbs of fish hooks. I recall finding Cowbird eggs in two or three Prothonotary Warbler nests in this little colony in previous years.—HOMER F. PRICE, *Payne, Ohio.*

Ring-necked Duck broods in New York State.—The Ring-necked Duck (*Aythya collaris*) is uncommon as a summer resident in New York and its breeding here is rare, if ever reported up to the present writing. It has been observed as a summer resident in the Finger Lakes section, in the Lake Champlain area, and in the southwestern Adirondacks. Records from Ithaca showed the average migration dates on Cayuga Lake, prior to 1936, were between February 18 and April 7, and from September 16 to October 29. Observations made in the Ithaca region by Benson during 1936 and 1937 showed this species as late as June 10 on Dryden Lake, June 15 on Labrador Pond, and late May on Spencer Marsh and Danby Pond. Each spring from 1939 through 1943 a flock varying from 15 to 40 birds, with drakes predominating, two to one, were observed on one pond at Visher's Ferry Flats, Saratoga County, regularly until the first of June, and in 1942 until June 20. On June 15, 1940, a pair of Ring-necked Ducks was observed by Benson near Rouse's Point on Lake Champlain, but there was no sign of nesting. In May, 1941, six pairs were found by Severinghaus on Lake Lila (Webb, Herkimer Co.).

Our first record of the breeding of Ring-necks in New York State was made in 1946 by Severinghaus who observed four pairs and two broods at Jones Pond (Brighton Township, Franklin Co.). Jones Pond, in the north-central Adirondacks east of Paul Smiths, lies at an elevation of 1652 feet. It consists of two shallow bays, west and north, connected with a deeper south bay by a body of open water. The west and north bays are from five to fifteen feet deep. The west bay is nearly filled with emergent vegetation, mainly cattails (*Typha*), growing on a bog mat of Ericaceous plants that have pushed out from the shore. In the remaining open water, buoyant aquatics, yellow pond lilies (*Nymphozanthus*) and sweet water lilies (*Nymphaea*), as well as a dense growth of submergent aquatics, nearly fill the bay with vegetation. The north bay is largely open water with a sparse growth of emergent and buoyant aquatics but a dense growth of submergent aquatics, while the south bay, about forty feet in depth, is almost entirely open water. The shore line of the pond is covered with a dense growth of alders and woody shrubs (except on the east side of the south bay where there are several summer camps), and behind these are tall, mature conifers. The road from Paul Smiths to Rainbow Lake passes close to the north and west bays.

On May 29, 1946, three pairs of Ring-necks were found on the north bay by Severinghaus, and identification was confirmed by two fellow workers. The birds

were all within 30 yards of the shore and were readily observed for fifteen minutes. Closer to the shore and at first out of sight were an additional male and female Ring-neck and seven young which were 10 days to two weeks old. The male was about 30 yards from the brood and the other three pairs were from 40 to 60 yards from the brood. When at last the entire group of birds was frightened, the three pairs without observed broods flew to the west shore of north bay, flying about 200 yards, and settled in the water close to the shore. The male which was apparently with the brood female flew about 200 yards up the east shore and the female and brood scurried off across the water, closed into a small group, and settled down about 20 yards off shore after covering about 100 yards of open water. All the birds remained in view, apparently not frightened sufficiently to seek cover.

On July 11, 1946, Severinghaus and a companion visited the pond again in hopes of locating the brood. The north bay was thoroughly searched but no ducks were seen. In the west bay, in a small area of open water about 20 by 40 feet in dimensions, a female Ring-neck with a brood of nine or possibly ten young was found. The young were very small—a week old or possibly younger. At first the observers were not seen and the brood, scattered over an area about six or eight yards square, was swimming among the lily pads. When we were seen, they clustered around the female and scurried across the water into the cattails. Then the female emerged and headed for us. She came within eight or ten yards of the canoe; then half flying, half swimming, she scuttled out of the small area, going away from the brood and into the main open-water area. We remained in place for about ten minutes, watching her antics and listening to the young call. When we left, the female led us down the channel to the main open-water area before returning to her brood. After this, two adult male Ring-necks and several adult Black Ducks were flushed along south bay but no additional broods were found.

It was apparent from the size of the ducklings that at least two broods of Ring-necks, one of seven and the second of nine or ten, were hatched on Jones Pond in 1946. Whether either brood grew to maturity is not known as the area was not visited again.—C. W. Severinghaus and Dirck Benson, *Wildlife Research Center, Delmar, New York.*

Food of the Lark Bunting in central Utah.—Lark Buntings (*Calamospiza melanocorys* Stejneger) were moderately abundant along sagebrush and rabbitbrush fence rows west of Nephi, Utah, on May 19, 1941. The stomach of one specimen, collected by F. C. Harmston and the writer, contained the following insects: 1 fly, 1 beetle, and 1 harvester ant, besides insect fragments. Also present was a spider, 65 seeds mostly of weeds, and two Russian thistle plant fragments. One of five Lark Bunting specimens observed about four miles north of Fountain Green, Utah, on May 21, 1941, was collected by the writer. Recognizable insects present in the stomach of this specimen were: 2 beetles (1 a weevil), 3 Hymenoptera, 2 of which were ants. In addition the stomach held 5 kernels of wheat, 1 sunflower seed, 7 other weed seeds and a few plant fragments. The bird specimens were identified by Drs. J. S. Stanford and C. L. Hayward.—George F. Knowlton, *Utah State Agricultural College, Logan, Utah.*

Fall migration of the Purple Martin.—In the January, 1947, issue of The Auk, Mr. Alexander Sprunt, Jr., had a speculative note on the date of first autumn movement of the Purple Martin (*Progne subis subis*). Perhaps the following observations on the post-nesting activity of the species in my neighbourhood may add something to the apparently scanty data on the subject. These observations were

made near Streetsville in the valley of the Credit River in Peel County, Ontario, Canada.

In 1942, there was, to my knowledge, no martin colony in the immediate neighbourhood. On July 25, the spruce trees around our house were 'invaded' by martins, mostly young and females. The young were still being fed and spent most of the day sitting on the spruce tree tips. This happened again the next day. On the 27th, to quote from my diary: "Very hot to-day. About 90°. Such a great swallow movement all day. High and low the sky was full of them—mostly Barn, many Purple Martins and Swifts. An endless milling about. Young were being fed in the air and it would surely be a wise parent that would know its own offspring in that mêlée." On the 28th the martins and swallows were gone and only an occasional martin was seen up to August 11, the last date for the species for that year.

In 1943 we had a martin house on our property with a single pair of resident birds which raised three young. On August 9, while these young were still in the nest, there was a martin invasion resembling that of the previous year. Fifteen to twenty birds were in and about the spruce in the morning and in the afternoon many more were milling about with swallows very high in the sky. After this date, numbers dropped abruptly and tapered off to the end of the month when the last were seen. In 1944 and 1945, no such concentration of the species was noted.

In 1946, five pairs nested successfully in the martin house, raising nineteen young (fifteen were banded July 28 by R. Baker and H. Southam of Toronto). All but two of these had left the nests by August 1 and from then until the 18th (when the last two young had flown) ten or twelve were to be seen daily and roosted in or on the house each night. On the 18th, a flock of twenty birds was around all day but none stayed to roost, and after that date numbers again dropped abruptly to seven seen on the 21st, five on the 25th, and so on until the last (four) were seen on August 30.

It appears, then, in this locality at least, that there is definite movement of martins as soon as the young leave the nest and before those of late nestings have done so. Of course these gatherings that I see could come from some local roost which might be occupied until much later in the season, the birds spreading from it daily in varying directions. But I do not think so. I know of no such roost in this region and there is such an abrupt drop in numbers after each assembly that it certainly appears that the birds are definitely 'on the move.' MARGARET H. MITCHELL, *Streetsville, R. R. 1, Ontario, Canada.*

Albinism in a flock of English Sparrows.—For the past eighteen years I have had under observation a small flock of English Sparrows that have frequented the area that surrounds the bird house in the zoo and that is devoted to the outside captive birds. During this period many generations of birds have existed, as several broods are raised annually.

In 1928 I first observed that this flock of sparrows contained many partially albinistic individuals. Albinism is not infrequent among birds, and may occur in any species. This lack of pigment in a bird always excites interest. Due to the albinistic markings it is comparatively easy to follow and scrutinize such unusual birds. It is not difficult to walk around the bird house and point out this flock to the bird student, so pronounced and permanent have the markings become. The flock consists of about fifteen birds and each bird displays one or more white feathers in the tail, scapulars and sometimes scattered among the contour feathers. I assume that much inbreeding has taken place among this flock and its ancestors, thus tending to isolate homozygous types. As a group the flock does not appear to be the typically

robust sparrow of our streets and byways. The birds seem to lack vigor, do not spend most of their time in the low bushes nor engage in the tussles usually seen among the males in the spring. In contrast they appear rather passive in their way of life, spend much time upon the ground, and are rather slow on the take-off when approached. I recently observed the ease with which a Sparrow Hawk (*Falco sparverius*) took a member of this flock. The falcon hovered for a second and then gently dropped upon the bird. This control factor may have prevented the flock from expanding into one much larger than it is at present.—MALCOLM DAVIS, *The National Zoological Park, Washington, D. C.*

Albino Bluebirds.—Two brothers, John Hill and Coleman Vickers, at their home fifteen miles north of Atlanta, Georgia, observed a pair of Bluebirds nesting in a box. On April 21, 1946, they saw the three fledglings emerge to fly, one of them an albino, which they photographed. The same parents then built another nest in a box a hundred feet distant, where on June 12, the boys summoned Mr. and Mrs. Athos Menaboni and Commander Ben Rigg. Of the five fledglings (photographed in colored motion pictures by Commander Rigg) three were albinos. The parent Bluebirds returned to the first box to nest a third time, and on July 28, the five fledglings of this brood, three of them albinos, were observed and photographed by Dr. Wallace Rogers, Mr. Ray Werner, and Mr. and Mrs. Athos Menaboni. Summary: in one season, three Bluebird nestings; of the thirteen fledglings, seven were albinos.—SARA MENABONI, *Atlanta, Georgia.*

A partial albino Cardinal.—While entering the National Zoological Park, Washington, D. C., by way of the Harvard Street entrance, I observed what appeared to be a strange bird perched in a small white oak tree. It continually gave the call note of the Cardinal, a *tsip, tsip,* and when I followed it up a small hill I was able, without the aid of binoculars, to identify it as a partial albino example of that species (*Richmondena cardinalis*). The entire plumage was white with the exception of the scapulars and back feathers which were olive in color, leading me to believe that the bird in question was a female.—MALCOLM DAVIS, *The National Zoological Park, Washington, D. C.*

The range of an individual Bob-white.—At sundown on July 23, 1946, six miles west of Hillsboro, Highland County, Ohio, I heard a bird utter a high-pitched call that had a rhythm like that of a Bob-white (*Colinus virginianus*). Upon tracing the call, I saw a male Bob-white perched on a strand of barbed-wire fence. The bird repeatedly delivered a high, squeaky call. To me, it sounded similar in quality to that of a flicker. The call was very much muffled and unmusical in comparison to the regular call of the species. Several times, the bird emitted a well articulated *bob-wank-wank.* Later, he gave a high, screechy *bob-white.* If the term can be appropriately used, it sounded as if the voice were 'rusty.'

With the aid of this odd call, the bird's movements could be followed rather easily. By July 29, six days later, the bird had traveled more than one and one-fourth miles in a straight line. Four days later, August 2, the bird had gone almost one and one-fourth miles in a different direction. By August 8, it had roamed in a zigzag fashion another one and three-sixteenth miles. All in all, over a period of 16 days, this one Bob-white was known to have covered nearly three and three-fourth miles.—GEORGE H. BREIDING, *Ohio State University, Columbus 10, Ohio.*

Northward extension of the breeding range of the Least Tern.—Dr. C. W. Townsend in his 'Birds of Essex County': 106, 1905, gives as the only certain record of

the Least Tern (*Sterna albifrons antillarum*) in the Ipswich region of Massachusetts the statement of C. J. Maynard in the 'Naturalist's Guide': 157, 1870, that he "found a few breeding at Ipswich." Dr. Townsend indicated that the date was in the late sixties, and then proceeded to point out that the species at the time of his writing did not breed regularly north of Cape Cod. In 1925, E. H. Forbush in 'Birds of Massachusetts and Other New England States,' 1: 123, stated that the breeding range at that time extended as far north as Duxbury. Subsequently, another advance of about ten miles occurred and for many years now the species has been a regular summer resident at Scituate.

During the seventy-five years following 1870 there have been but casual records of the species at Ipswich which is thirty-three miles north of Scituate, air-line, and easily double that following the shore. In 1944, Miss Katherine Tousey of Medford observed the species in Ipswich although I was unaware of this when, on June 10, 1945, I saw several Least Terns at the mouth of Fox Creek which empties into the Ipswich River just before the latter discharges north of Ipswich Beach. Startled by observing two of the terns practically alight in turn on the tail of a Herring Gull passing leisurely by—and departing in a sudden hurry—I made a lengthy detour through the salt marshes and ultimately arrived back on the other side of the creek at a spot only some two hundred yards distant. A total of ten Least Terns rose to greet me from a slightly raised mound in the marsh and mud flats. This mound was one of a number of old clam-shell dumps of great antiquity. The reception accorded me was little short of vicious and, with the full realization of the importance of the discovery, I decided the danger of disturbing and possibly breaking up the colony outweighed the scientific proof of collecting an egg.

On June 24, I returned again, approaching within about a hundred yards, and noted five Least Terns in the air at once. On July 8, there were still four birds and these were acting as though they were two pairs. At this late date there seemed little likelihood of harming the colony and, accompanied by my wife, I went up to the mound. One of the pairs by that old childhood game of: "You are getting colder—warmer—hot!" led me on until, looking down, I saw a shallow nest scooped out of the powdered shells right at my feet. There were two eggs.

On July 21, only one bird remained at the nesting site and this bird showed but casual interest in us. On the 22nd we found three adults at the south end of Ipswich Beach, several miles distant, and again on the 29th two birds. On August 8, Dr. Winsor M. Tyler, J. A. Hagar (the State Ornithologist), Mr. L. B. Fletcher and I made an extensive sea trip as guests of Mr. Cornelius Crane. We encountered the Least Tern almost immediately upon pulling out from the Crane's landing in the Castle Neck River behind Ipswich Beach, more birds at the southerly end of the beach, and two or more in the Ipswich River at the north end of the beach.

On May 26, 1946, I saw one bird at the mouth of Fox Creek, but the breeding site had been shifted, for some reason, to the beach itself. I did not follow the nesting period there, but on August 4, at two different locations at the south end, I saw groups of four birds in the air at once and judged by the numerous ones flying about that there were at least ten present—probably more. One bird caught a fish, rose straightway high into the air, dropped the fish, and then caught it again while still some thirty feet above the water.

This northerly progression of the breeding range of the Least Tern acquires added interest when taken with the breeding of the Black Skimmer at Plymouth as reported by J. A. Hagar in the Auk, 63: 594–595, for October, 1946.—WENDELL TABER, *3 Mercer Circle, Cambridge, Massachusetts.*

Lesser Black-backed Gull on Long Island.—On March 1, 1947, the writers, together with Richard Ryan of New York, observed an adult Lesser Black-backed Gull (*Larus fuscus* subsp.) standing upon the ice on the Hempstead Reservoir, Hempstead, L. I. Conditions under which the bird was observed were excellent. It was standing in a group of gulls with a Herring Gull immediately beside it and a Greater Black-backed Gull next to the latter. The difference in size between the two Black-backs was strikingly apparent. In addition, the mantle of the Lesser was much browner and a shade lighter than that of the Greater, and the difference in foot coloration was noticeable. The birds were observed and compared for a period of about fifteen minutes with a 33X scope.—PHILLIPS B. STREET AND WILLIAM W. LUKENS, JR., *Philadelphia, Pennsylvania.*

Barn Owl in Quebec.—On September 8, 1944, the Quebec Zoological Garden received a live specimen of an adult Barn Owl (*Tyto alba pratincola*) from Thetford Mines, Megantic County.

As I have not been able to find any published record of this species for the Province of Quebec, and moreover having secured three other unpublished records from reliable observers, I believe the following records warrant publication.

The specimen brought to the Quebec Zoo was caught in a barn in the suburb of Thetford Mines, Megantic County, on September 3. The bird was in very weak condition and died a few hours after its arrival at the Zoo after which it was sent to the Quebec Provincial Museum.

Reverend J. A. Bergeron of Nicolet Seminary, through personal correspondence, tells me that a Barn Owl was killed in 1936 at St. Félix-de-Kingsey, Nicolet County. The mounted specimen is preserved in the institution's museum.

From L'Assomption, the late Gedeon Boucher reports that in mid-November, 1926, an adult Barn Owl was killed at L'Assomption College. The specimen was mounted and owned by a professor of the institution who died in 1943. Its present owner is not known.

The most interesting record comes from Reverend Brother Florian V. Crete, C. S. V. Director of the Museum of the Deaf and Dumb Institute in Montreal. Through personal correspondence, Brother Crete tells me that in 1931, at Berthierville, Berthier County, Reverend. Brother Andre Paquette observed a nesting pair in the steeple of the church of Berthierville. Four young came out of this nest at least two of which were killed and preserved in museums. The first one, a male, was killed on November 10, 1931, and is now in the Museum of the Deaf and Dumb Institute of Montreal (No. 31/16). The second one was given to the museum of Ste. Anne-de-la-Pocatiere College in Kamouraska County.

Acknowledgments are due to those who contributed data for this paper and kindly permitted publication of their own records.—RAYMOND CAYOUETTE, *Quebec Zoological Society, Charlesbourg, Quebec.*

The Mourning Dove breeding in Lévis County, Quebec.—It is comparatively recently that the Eastern Mourning Dove (*Zenaidura macroura carolinensis*) is a breeding bird in the Province of Quebec. Mr. L. McI. Terrill, in the annual report of the Province of Quebec Society for the Protection of Birds (1941: 15), tells that he believes his record of a breeding bird at Lanoraie, Berthier County, in 1922, is apparently the first breeding record for the district of Montreal. Since that time, in that district, the Mourning Dove is more common and nests locally.

From the Quebec city district, the late Mr. G. Langelier had reported in The Auk (40: 15, 1923) an adult killed at Cap Rouge on April 12, 1923, and another one killed at the same place on April 17, 1939 (Can. Field-Nat., 53: 121, 1939).

More recently, Mr. Ls.-A. Lord of the Provincial Museum secured an adult female specimen on June 27, 1944, at St. Nicolas, Lévis County, some ten miles southwest of Quebec city, on the south side of the St. Lawrence River. That female specimen had an enlarged ovary of 6 millimeters in diameter. At the same place on next July 14, Mr. Lord saw or heard at least three pairs of Mourning Doves in the woods between St. Nicolas and St. Apollinaire, in Lotbiniere County. On July 20, 1944, he saw one near Quebec bridge, on the north side of the St. Lawrence River. In the woods of St. Nicolas on next July 26, he again counted seven birds. Six birds were also seen on August 7, and on August 10, 1944, he killed for the Museum two specimens (Nos. 5257 and 5258, QPM) at St. Nicolas. One of those specimens, an adult male had enlarged gonads, and the other one, an adult female, had enlarged ovaries with well developed oviduct; the largest ovary measured 11.5 millimeters in diameter.

On August 15, 1944, Dr. Richard Bernard, Mr. Lord and the writer went to the St. Nicolas woods to see those Mourning Doves. From 7 A. M. to 9 A. M. we counted eleven birds, seen or heard cooing. At least four distinct birds were heard cooing. On August 27, of the same year, the writer still counted seven birds at the same place.

It is obvious that the Mourning Dove breeds very locally in our district. Though no nest has been observed in the St. Nicolas woods, the above records are, I believe, sufficiently conclusive to admit that this species actually breeds in the region of Quebec. It is interesting to note that the bird extends its range northward.—Raymond Cayouette, *Quebec Zoological Society, Charlesbourg, Quebec.*

Upland Plover in Thunder Bay District, Ontario.—On May 23, 1946, Dr. A. E. Allin and myself, accompanied by some members of the Thunder Bay Field Naturalists Club, saw four large plover-like birds about four miles west of Fort William. On closer examination these proved to be *Bartramia longicauda*. Dr. Allin and I again visited the locality on June 18 and while the birds were seen, no evidence of breeding could be obtained. However, on June 30 I again visited the spot and, assisted by Mr. John Speakman of Toronto, who was doing field work in the district, made a thorough search of a large, rough pasture where we suspected one pair to be nesting. We were fortunate in capturing and examining one young bird about a week old; the actions of the parent bird left no doubt as to its identity. The second pair apparently nested in a neighbouring field. This is the first known record of this species in this district, and as the whole country was originally heavy bush land, it is undoubtedly a newcomer.—L. S. Dear, *Port Arthur, Ontario.*

Sabine's Gull on Long Island, New York.—On March 25, 1945, while observing the ducks on Hempstead Lake, Nassau County, Long Island, N. Y., I approached a point where the shore-line extended a few yards into the lake to form a small mud flat. On this flat were sitting about half a dozen Green-winged Teals, and standing amongst them was a gull, distinctly smaller than the teals on direct comparison.

As I drew nearer, the teals flew off, but the gull remained. At this distance the bill and legs appeared dark while the bird was unpatterned gray above and white below. However, another few yards closer exceeded the tolerance of the bird, and it spread its wings and took off, giving me a perfect view of the mantle and tail. The unmistakable diagnostic wing-pattern of a Sabine's Gull (*Xema sabini*) was clearly evident, and the forked tail had a very narrow subterminal bar indicating that it was an immature bird. The gull began to wheel upward in extremely small circles, and upon reaching a high altitude veered off and disappeared from sight. A few days later some observers combed the lake but could not locate the bird.

Except for the fact that the bird was utterly unmistakable, I would be quite hesitant to report this observation, as the locale is extremely unusual, and there has never been a spring record for Long Island.

A. D. Cruickshank, in 'Birds Around New York City': 236–37, 1942, lists the bird as collected but twice, once at Raynor South, July, 1837, and again at Gardiner's Bay, October 6, 1899. In addition, there are four sight records, one in late September, and three in October.—Dr. M. A. Jacobson, *New York, N. Y.*

Northern Eider on Martha's Vineyard.—On June 16, 1946, while my son-in-law, George G. Daniels, and I were walking along the beach from Gay Head to Menemsha, on Martha's Vineyard Island, Massachusetts, we came across the carcass of a Northern Eider (*Somateria mollissima borealis*). This carcass was sent to the American Museum of Natural History, New York, where its identity was verified by Dr. Zimmer as noted in a letter of acknowledgement sent to me. In view of the very few authentic records of this bird from as far south as Massachusetts, the publication of this account in The Auk seems desirable.—Edward L. Chalif, *Short Hills, New Jersey.*

European Teal in northwestern Pennsylvania.—On May 11, 1946, a male European Teal (*Anas crecca*) was discovered about a mile and a half west of Linesville, Crawford County, Pennsylvania. The bird was seen in a small temporary marsh area along the road which runs westward from the town to the shore of Pymatuning Lake. The following day the bird was still present and was observed by a number of bird-lovers from the Tri-State Area, including such capable field ornithologists as Messrs. M. B. Skaggs and G. M. Cooke of Ohio, H. D. Mitchell of New York, G. M. Thorpe, and R. L. Fricke of Pittsburgh, Pennsylvania. As far as the writer is aware this constitutes the first record for the species in western Pennsylvania; no previous records have been mentioned by Mr. W. E. Clyde Todd in his 'Birds of Western Pennsylvania.' The bird was watched for hours under ideal conditions and at a distance of not more than 200 feet. The writer viewed it through a pair of Bausch and Lomb 8 x 40 binoculars, although the distinguishing field marks were discernible with the naked eye, and comparison with the Green-winged Teal (*Anas carolinensis*) was made possible by the presence of one or more males of the latter during all of the observations. The solitary European Teal plainly lacked the vertical white bar in front of the wing, which was very obvious in the male Green-winged Teals, while a horizontal white bar above the wing was plainly evident on the former and not at all present in the case of the latter species.—William C. Grimm, *P. O. Box 424, Linesville, Pennsylvania.*

RECENT LITERATURE

Roseate Spoonbills at home.[1]—Robert P. Allen was commissioned in 1939 by the National Audubon Society to make a thorough investigation of the Roseate Spoonbill in the United States to discover as much as possible of its life history, behavior, and ecology with a view to determining the reasons for its scarcity and the measures to be recommended for improving the situation. For two years he lived among these birds in Florida and Texas and brought back a great fund of significant information. His formal report was published by the Society in 1942 (*cf.* review in The Auk, 60: 291, April, 1943), giving the details of his careful studies. The present volume, intended for the more general reader, is the informal story of his experiences in the field in the course of his work. While the serious student will, of course, turn to the formal report for the full details, the present work contains enough of the broad picture to show what was accomplished.

Written in a breezy style, the account leaves the reader with a clear picture of this fine bird, of the country in which it lives, and of the conditions, favorable and unfavorable, that affect its life. The problem of its rehabilitation, at least in Florida, appears to lie in the disproportionately low percentage of breeding adults that return to this area in the spring, since only birds at least 35 months old are able to breed. Of such it is calculated that there are but 0.06 per cent of the total of spring migrants (erroneously given as 0.006 per cent on the basis of two out of 305!). Studies are still needed to find the winter home of the Florida birds and to determine the possible cause of the low ratio of adults that return for nesting. Fortunately the picture in Texas is more hopeful.—J. T. Zimmer.

The Ruffed Grouse.[2]—Probably no native American game bird has been investigated by larger numbers of wildlife experts and been the subject of graver concern to conservationists than the Ruffed Grouse (*Bonasa umbellus*). The efforts expended in its behalf have been worthy of a book-length treatise for many years. This impressive volume, though not intended to be an exhaustive work, is designed "to cover the high spots of the life story, the ecology, and management of the ruffed grouse in a manner interesting to the sportsman, the nature lover and the lay reader, and at the same time be accurate and adequately documented for the technical man in the field of wild life management." (p. X).

The author began the study of the species in 1929 under the auspices of the New York State Conservation Department, the overall purpose being to determine reasons and remedies for periodic fluctuations in numbers. He worked on the project for over seven years, largely on the Connecticut Hill Game Refuge near Ithaca, New York. The results comprise the basic material for this book although it has been broadened by the author's experience gained after eight years' additional field work on wildlife in the northeastern United States.

The first two chapters are introductory in nature, considering briefly classification, nomenclature, coloration, pterylography, and history in the eastern United States. Recent taxonomic revisions are outlined. It is the author's feeling that the number of subspecies should be reduced to four, namely, *umbellus*, *togata*, *sabini*, and *umbelloides*.

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[1] Allen, Robert Porter. 'The flame birds.' 8vo, pp. XI + 233, 16 pls., May 26, 1947. Dodd Mead & Co., New York. Price, $3.50.

[2] Edminster, Frank C. 'The Ruffed Grouse. Its Life Story, Ecology and Management.' 8vo, pp. xxvi + 385, pls. 1–56, figs. 1–17, 1947. The Macmillan Co., New York. Price $5.00.

Much of the information on life history is contained in the third chapter entitled "Biography." Here in story form is presented a typical course of events in the life of the grouse from one spring to the next. The text reads easily and entertainingly. Certain items of information that cannot be readily woven into the story's fabric are given under subheadings at the chapter's conclusion. Interesting though this chapter may be to the layman for whom it was intended, the ornithologist will undoubtedly desire more substance in the form of specific data and discussions. Moreover, he will very likely feel that numerous statements need either supporting evidence or clarification. The author applies Arthur A. Allen's "sex rhythm" theory, founded on studies of captive Ruffed Grouse, to wild birds, but renders no qualifying remarks or observational information. An incubating grouse is shown to give a deflection display in the presence of an intruding fox (p. 37), but to fly away when approached by a dog (p. 36). Is this difference in response of common occurrence? If so, what are we to infer? A weasel is described attacking and killing a drumming grouse (p. 50), yet later on in the book (p. 205) the statement is made that, although weasels are capable of taking grouse, evidence is lacking to identify their work. Is the description, then, based on evidence or supposition? The author indicates (pp. 45–46) that grouse are conditioned by experience to avoid being shot. He goes on to say: "With each escape from the hunters' bullets the grouse becomes more wary and more able to make a successful getaway. This ability to dodge shot and baffle hunters has been developed in a relatively short time. Wilderness grouse even today sometimes exhibit the fool-hen characteristics that most grouse possessed when the white man first introduced them to guns." These statements imply, on the one hand, that the elusiveness of the grouse, when confronted by the gun-bearing white man, is innate behavior which the species has recently acquired and, on the other hand, that certain individuals, not having inherited the behavior, acquire it by conditioning. Are we to deduce that the elusiveness of the grouse is a modern development? It is difficult to believe that the Ruffed Grouse has modified its behavior since the time when guns were turned upon it. On the contrary, it seems more logical to believe that the bird responds to the shot from a gun in the same innate manner that it has responded for centuries to the swift attack of such an enemy as the Cooper's Hawk.

The next seven chapters deal with ecology. The ornithologist will find them satisfyingly thorough and in marked contrast to the presentation of life history. They are well documented; they consider their respective titles from many logical approaches. Since the author's investigations were confined to northeastern United States, the information is primarily limited to that section of the species' range.

Many pages are devoted to different cover types and those selected by grouse under various circumstances. Apparently, large sections of a single cover type "are relatively unproductive of grouse, no matter what the type" (p. 70). Optimum year-round cover must contain a coniferous type, a mixed hardwoods type with available edge, and open type (*i. e.*, "open land, overgrown land, slashings, and roadways" (p. 80)). The food taken by the grouse is impressive in its diversity. The author points out that "some 374 kinds of plants and 131 kinds of small animal life" are "already known to be eaten by it in measurable quantities in the Northeast" (p. 103). Food types expectedly vary from season to season. The twenty-five primary foods of grouse are all plant foods and usually compose from 65% to 88% of the food of adult grouse at any time of the year. These foods are listed and discussed in detail. Three tables totalling twenty pages in length list all foods taken by grouse irrespective of quantity. According to the author, food supply is not a serious limiting factor.

"Three are few species of game birds that have as little trouble finding food year in and year out as the ruffed grouse" (p. 176). The species is shown to be seriously affected by adverse weather. In fact, the author concludes (p. 194) that weather conditions "play a big part in grouse fluctuations both great and small." The interrelationships of Ruffed Grouse to predators provide interesting reading. Of the mammalian predators, those listed in probable order of importance for south-central New York are foxes, weasels, and skunks; of avian predators, Great Horned Owls, Goshawks, and Cooper's Hawks. The author is of the opinion that predators may be a limiting factor only when grouse populations are "below the peak of their upward trend" (p. 221). The many diseases and parasites commonly affecting the species are taken up separately. The author does not consider disease a serious threat in any given area in most years, but when grouse are abundant over a wide range, or when weather conditions are such as to hasten reproduction of parasites, disease will become an important mortality factor. When disease is rampant among grouse "it is primarily effective in killing the young birds during the summer" (p. 251). Factors affecting productivity and populations seem to have been carefully analyzed. The author recognizes the fact that the Ruffed Grouse exhibits periodic fluctuations over its optimum range, but he is not ready to refer to them as population cycles. "Cycles" would indicate that changes in numbers of species would take place regularly according to uniform time intervals and would usually include a precipitous decline phase (p. 310). He would call them simply "periodic fluctuations" (p. 322) since "they are not sufficiently regular to be caused directly by some all-pervading common cause. They are inconsistent geographically, both in time of occurrence and severity of action."

The eleventh and final chapter takes up the subject of management which is based "on the whole ecology of the grouse; on its cover preferences, food requirements, principles of interspersion; the need of drumming logs, dusting sites, and escape shelter; and the relations of the bird to other animals and to man" (p. 326).

Each chapter is concluded by citation sources and suitable references. The book has a very detailed index, thereby greatly enhancing its usability. The fifty-six plates are from photographs, all of them excellent. The appearance of the text is enlivened by William Montagna's pen-and-ink drawings at the chapter endings.

The author has succeeded admirably in fulfilling the aims for which the book is designed and he is to be heartily congratulated.—Olin Sewall Pettingill, Jr.

Practical conservation.[1]—Dr. Graham has written a comprehensive discussion of the fundamental relationship existing between the land and the wildlife it supports or should support. There is no question but that both land and wildlife in America have been sadly misused in the past and efforts to improve them have been largely independent of each other. It is the author's studied conclusion that practices that are soundest for the betterment of the land, for its most economical use, are also best for the animal life of the region, providing it with the shelter and food without which it is unable to survive. For example, stream banks and gullies must be planted to permanent cover crops to prevent erosion, windbreaks are needed to protect certain open areas, hedges are useful as fences, neglected and unusable field edges can become a menace to crops unless planted to some neutral vegetation, drained marshes and swamps often prove at least unproductive and useless unless restored to their former condition, and woodland is most profitable if scientifically cropped instead of cleanswept. All of the recommended procedures in such cases give back to the wild

[1] Graham, Edward H. 'The land and wildlife.' 8vo. pp. XIII + 232, pls. 1–32, 1947. Oxford University Press, New York. Price, $4.00.

creatures the places and conditions needed for them to live and raise their young. They can be especially successful if the measures adopted are deliberately selected with a view to the double purpose.

There are also measures that may be taken without particular regard to the economic use of the land, such as the establishment of wildlife refuges or the simple preservation of bits of the fast-disappearing primeval forest and countryside, with an eye to their recreational or educational value. Such terrain has added utility as a standard guide to the capabilities of similar adjacent terrain, to which the natural climax vegetation gives a valuable clue.

These matters are taken up by Dr. Graham in considerable detail and with much practical suggestion. The book begins with a historical review of man's appreciation of his fellow animals and his developing interest in wildlife management and control. It closes with the idea that wildlife is an integral part of the land pattern and that true conservation involves not merely preservation but wise use of natural resources. The helpful discussions deserve careful consideration, not only by professional conservationists who may already be keenly aware of the problems, but by land managers and others who can put the ideas into practice on privately owned lands. The book is thoroughly recommended to all who are interested in the preservation of our native fauna.—J. T. Zimmer.

Birds of Maryland and the District of Columbia.[1]—This little work (in offset printing) gives an annotated list of 338 species and subspecies accepted as definitely known or recorded from the area, and 27 hypothetical forms. The authors personally examined specimens of 89 per cent of the accepted forms and most of the remainder were originally recorded also on the basis of collected material. A few have been admitted through sight records by one or more competent observers on more than one occasion. Some of the discarded records without this certification are not necessarily unauthentic, but the writers have wisely held them in questioned abeyance. Since there appears to have been no complete Maryland list since 1895 (the District of Columbia has been more fully treated), this list should serve as a useful handbook for bird watchers in the region.—J. T. Zimmer.

The European Blackbird.[2]—As this book is a detailed account of the life history of one of the best known and commonest of British birds, the reader is bound inevitably to compare it with David Lack's 'Life of the Robin,' and such a comparison is invited in a foreword by G. Carmichael Low. This is unfortunate, because the book does not bear too close a comparison.

Many valuable facts are brought together and discussed in the light of the author's long experience, but the interpretation of these facts would have been more convincing if he had availed himself of modern techniques such as color banding. Also too many sweeping statements are made without reliable evidence, and the presentation of some of the material is merely repetitious.

All the way through, and at every possible opportunity, the author goes to great pains to stress the highly individualistic behavior of the Blackbird. Granted that since the bird is a living organism, possibly one with a glimmer of intelligence, its reactions will not always follow a predetermined pattern, the author's insistence

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[1] Hampe, Irving E., and Kolb, Haven. 'A preliminary list of birds of Maryland and the District of Columbia.' 3vo (paper covers), pp. XI + 75 4, 8 pls., 1 map, 1947. Natural History Society of Maryland, Baltimore.

[2] Hillstead, A. F. C. 'The Blackbird.' A contribution to the study of a single avian species. With a foreword by G. Carmichael Low. Pp. 1–104, figs. 1–19, 1945. Faber and Faber Limited, London.

nevertheless seems a little self-conscious and some of his arguments take on the nature of a straw man.

On the whole it can fairly be said that as a study in bird behavior the work fails to live up to expectations, and what could have been a most important contribution turns out to be pretty much of a disappointment. On the other hand the photographic illustrations are excellent, informative, and very well chosen.—CHARLES VAURIE.

British bird life.[1]—This book is an addition to the two preceding volumes, "Birds of the Day" and "Birds of the Night." These two were great successes and one glance at 'More Birds of the Day' is sufficient to see why popular request pressed for more of the kind.

The 95 photographs included in this latest number in the series cover 33 different species of British birds, some of them very common and familiar and others extremely local and rare. The number of photographs devoted to a species varies from a single picture to a complete sequence or illustrative series. The authors tell us that their choice was made from the points of view of interest and variety. In this they have been successful and their pictures, of course, are all very fine, and many are of outstanding quality and beauty.

Especially noteworthy is a sequence showing a young Cuckoo expelling the eggs of its foster parents from the nest. These are probably the finest photographs of behavior ever taken. Other remarkable series are those on the Hobby and Montagu's Harrier feeding their young, on domestic incidents in the life of the Rook, Stone Curlew, and Slavonian Grebe.

To these splendid and fascinating photographs which are justification enough in themselves, the authors join a text full of valuable field observations on behavior, call, food, and recognition notes, nest building, incubation, food habits, and methods of feeding.—CHARLES VAURIE.

Danish birds.[2]—This small book, prepared by the Danish Section of the International Committee for Bird Preservation, is a modern review of the breeding birds of Denmark. It is divided into two sections. The first is an annotated systematic list of 217 species which are known to have bred in the country during the 19th and 20th centuries. Included are 30 species which may possibly have bred in earlier times, but which have long ago disappeared. The systematic order followed is that used by B. W. Tucker in the 'List of British vertebrates,' 1935 (British Museum, Natural History).

The second section is an analysis of the present status of the birds in the systematic list. Excluding the 30 hypothetical species, the list stands at 187 species. During the last hundred years great changes have affected this number. Ten species have been extirpated and 17 others have shown a great decrease. Of the remaining 160, a goodly number, 18, are only sporadic or exceptionally breeding species, and only 15 have shown an increase during the last century. Thirteen species are known to be recent immigrants, the years when they were first discovered ranging from 1905 to 1941. The remaining 114 species are not itemized and are apparently holding their own.

The breeding bird fauna of Denmark, as expected, is seen to be rather small, but in spite of the relatively restricted area, several birds have characteristic distributions

[1] HOSKING, ERIC J., AND NEWBERRY, CYRIL W. 'More birds of the day.' Pp. 1–127, pls. 1–84 (95 figs.). 1946. Collins, London.

[2] JESPERSEN, POUL. 'The breeding birds of Denmark. With special reference to changes during the last century.' Pp. 1–79, 14 figs, including cover, 1 map. 1946. Einar Munksgaard, Cpoenhagen. Price 6 Danish crowns.

within its boundaries. Most interesting are the following which reach the northern limit of their breeding range in Middle Europe: Golden Oriole (*Oriolus oriolus*), Marsh-Warbler (*Acrocephalus palustris*), Great Reed-Warbler (*A. arundinaceus*), Chiffchaff (*Phylloscopus collybita*), Thrush-Nightingale (*Luscinia luscinia*), and the Barn Owl (*Tyto alba guttata*).

The text is in English and includes the corresponding Danish names. This book is little but full of interesting data. It is handsomely printed and is illustrated by a number of pleasant field sketches by Johannes Larsen.—CHARLES VAURIE.

Footnotes on nature.[1]—This engaging volume contains the informal narrative of numerous excursions undertaken by the author and several boon companions mostly in the not-too-distant environs of New York City. The party fundamentally consisted of four individuals made known to the reader only as the Artist, Herman the Magician, the Astronomer, and, of course, the author, with occasional temporary additions such as the Medical Student, the Falconer, and others. Each of the members of the party had his favorite branch of nature but all were interested also in the broader aspects, and with four pairs of enthusiastic eyes at work, there seems to have been little that escaped observation.

This is not, however, a dry list of things found on the excursions, although there is a catalogue of them at the end. In the general text, such matters are discussed as they came to hand, and if some of them brought corollary matters to mind, they also are discussed—perhaps the story of the Bartrams and *Franklinia*, perhaps some boyhood recollection, perhaps the subject of birds' nests, warbler migration, ferns or flowers. In last analysis, they concern nature in some form or other and hence are highly pertinent.

As might be expected in a book by John Kieran, there are frequent quotations from the classics, and attractive illustrations are furnished by wood engravings by Nora S. Unwin. Readers familiar with the natural history of the New York City region and parts of New England will enjoy comparing their observations with those of Mr. Kieran and his friends, while those not so familiar will learn much of what is to be found hereabouts. Both will find pleasure in the reading.—J. T. ZIMMER.

The English Robin.[2]—The first edition of this work appeared some years ago (*cf.* review in The Auk, 60: 609, Oct., 1943). The text of the present edition is largely the same except for certain chapters to which Mr. Lack has added new matter. As a rule, these additions serve largely to bring the subject more up to date by the inclusion of more recent discoveries or the inclusion of more supporting data. In at least one case—that of 'optimum spacing' of territories—Mr. Lack has become more positive than before of the fallacy of the theory.

Several new illustrations have been added and one is replaced by a better photograph. Students not familiar with the original volume will find this book a mine of information on the English Robin, with a treatment equaled by few accounts of single species.—J. T. ZIMMER.

A naturalist in the field.[3]—One of the most active of the field naturalists of recent times has been Willoughby Lowe whose expeditions in many lands in the Eastern Hemisphere so substantially enriched the collections in the British Museum of Natural History. The list he appends to the present volume shows an impressive

[1] KIERAN, JOHN. 'Footnotes on nature.' 8vo, pp. VI + 279, 20 figs, 1947. Doubleday & Co., Garden City, New York. Price, $3.00.

[2] LACK, DAVID. 'The life of the Robin.' 16mo, pp. XVI + 224, pls. 1–8 (1 col.) figs. 1–6, June 25, 1946. H. F. & G. Witherby Ltd., London. Price, 8/6.

[3] LOWE, WILLOUGHBY P. 'The end of the trail.' 8vo, pp. 1–178, 19 pls., 1947. James Townsend & Sons, Ltd., Exeter.

number of new forms which he discovered and brought back for study by various specialists. An uncounted number of other, little-known creatures he helped to make better known by the observations he recorded and the specimens he secured. Many of these are discussed briefly in the running narrative of some of his experiences which comprises the present book.

Mr. Lowe has already given us an account of other expeditions in his earlier book, 'The trail that is always new' (1932), and the present volume treats of still others—Tunisia, Indo-China, the mid-Sahara, Tanganyika, and the Gold Coast are here represented. The narrative is filled with interesting—often amusing—accounts of the places visited, the people and peoples met, the conditions encountered, and, of course, the animals discovered. There are numerous comments on the behavior and other characteristics of many of the birds, mammals, and other creatures, most of which are duly identified in footnotes by their Latin names. One could wish that there were even more of these observations for it is evident that Mr. Lowe was a good observer as well as a keen collector. In a general book of travel, however, the author must cover many phases of the subject and keep the text in balance in order to interest various types of readers. It may be said that the present book has ably succeeded in this respect. Readers interested in natural history will find here a great deal to their liking.—J. T. Zimmer.

Crow shooting.[1]—The contents of this book may be of value to a crow shooter but to an ornithologist many of the remarks on the habits of Crows are just so much callous nonsense. The tone of what to expect is set off at the very start by gross and wilful exaggerations as to the depredations caused by the bird. We are told on the authority of anonymous "reliable surveys" that in 1941–1942 "there were sections of Saskatchewan where fully 85 per cent of the duck nests were ravaged by crows" and that in 1940 "crows destroyed 16,300,000 eggs and ducklings," and in 1946 the depredations "had risen to a kill of 30,000,000 ducks." These last two figures were given on the authority of Ducks Unlimited. Before accepting such sensational statements, ornithologists cannot be blamed for insisting on more reliable and less prejudiced "evidence."

One cannot help wondering at a mentality which, while permitting the calling of a bird by all sorts of strong names, "cowardly" being one of the mildest, advocates the use as decoys of tethered, crippled or live Crows, or of tethered or caged cats and foxes. An unbiased reader might apply the word "cowardly" to other than the Crows.

Such a reader will not be impressed by the pious statements and crocodile tears which are shed on the fate of the "many millions" of song and game birds, or on the farmer's hard lot, when the author rather naïvely states in his next paragraph that Crow shooting is justified because it "provides such a wonderful all-around training for the scattergunner that he is shortly able to hold his own in any hunting party" and improve his marksmanship "to the point where he enjoys a vast satisfaction in his gunning prowess."

Although I take it from Mr. Popowski that shooting is to him the most agreeable way to dispose of Crows, he has a good word to say for trapping. One of the advantages of this method is to provide gun clubs with a supply of live targets, the only drawback being that often two or three live Crows have to be left in the trap as decoys, and "It goes against my grain to leave a single one of the rascals alive, when I can whack it down." But "in order to get the maximum value from such captives, I tie bits of branch along the shanks of their legs, using thin wire to hold the clogs in

[1] Popowski, Bert. 'Crow shooting.' Pp. XIV + 216, 49 figs., 1946. A. S. Barnes and Co., New York.

place." The irritation, which Mr. Popowski assures us is painless, causes "vociferous cursing [which] is certain to bring other birds."

This reader, for one, feels that the mentality which impels a man to kill at any cost, be it a lowly Crow, has nothing to do with sport and certainly does nothing to promote conservation. The control of Crows should not be left in the hands of self-appointed irresponsibles, but should be carried out by qualified agencies after study of local situations reveals the need of it.

The book is illustrated by a few photographs and a number of caricatures by Gordon Elliott; the caricatures, at least, are amusing.—CHARLES VAURIE.

Tasmanian birds.[1]—This little book, although presented as "a book for the bush," contains in condensed form information about all the birds occurring in Tasmania, native as well as introduced. Included are 229 living native birds, breeders as well as visitors, and 10 or so introduced species. Of the native birds, 14 of the species are peculiar to Tasmania. The introduced species are mostly common European species, the Skylark, Goldfinch, House Sparrow, Tree Sparrow, Blackbird, and the Starling. In Tasmania, too, they have become common with the exception of the Tree Sparrow which may have died out. The other exotics are the Chinese Spotted Dove, California Quail, European Partridge and several pheasants.

The value of the book, of course, is as a field guide. The field marks are emphasized, and included also are brief statements as to habitat, general habits, food, song, nest and eggs. A paragraph of general field notes, often of much interest, supplements the description and sums up in a few lines the author's experience with the bird.

The size is made for the pocket, but although it should prove to be very useful "in the bush," it does more than just provide a quick means of identification. Strictly speaking, however, its value as a means of field identification would have been greatly increased if, instead of the few random photographs, simple diagrammatic drawings such as illustrate Peterson's Field Guides had been included.—CHARLES VAURIE.

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OBITUARIES

FREDERICK NUTTER CHASEN, a Corresponding Fellow of the American Ornithologists' Union, was drowned at the age of forty-five in the Straits of Malacca, about September 1, 1945, when the vessel on which he was making his escape from Singapore was sunk by enemy action two or three days before the fall of that city. He was born in Norfolk, England, and served with the Norfolk Yeomanry in 1914–1918, during World War I. His interest in natural history was greatly increased by his nine years' association with the Norwich Museum from 1912 to 1921. In the latter year he was appointed Assistant Curator of the Raffles Museum in Singapore, Straits Settlements, and served as Director of the Museum from 1932 until his death. Through his association with H. C. Robinson and C. Boden Kloss and years of collecting in the Malay Peninsula, Sumatra, Java, North Borneo and the islands of the South China Sea and the Gulf of Siam, he became the leading authority on the mammals and birds of Malaysia.

Chasen was elected a Corresponding Fellow of the A. O. U. in 1934 and a British Empire Member of the B. O. U. in 1939. Some of his earlier papers were published with Boden Kloss, but his own publications were numerous and important. Among the most important were the third and fourth volumes of Robinson & Chasen's 'Birds of the Malay Peninsula,' 1936–1939, and his 'Handlist of Malaysian Birds,' 1935, and that of 'Mammals,' 1940, which appeared in Bulletins 11 and 15 of the Raffles Museum. A bibliography of his bird papers may be found in 'The Ibis' for 1946, pp. 529–530.—T. S. PALMER.

OSKAR HEINROTH, Honorary Fellow of the American Ornithologists' Union, was for many years Germany's most popular ornithologist. Publicity of an author and lecturer but rarely corresponds with his worth as a promoter of science. Heinroth, however, like a few other pioneers, worked as much in the depth as in the breadth. His original mind had systematically helped to open an immense new field of research—the comparative study of animal behavior, which is gaining ever increasing importance under the leadership of Konrad Lorenz, N. Tinbergen, and other sagacious observers.

In his study of live animals, which he had begun as a small schoolboy, nothing attracted him as much as registering and analysing the instinctive actions, especially of birds, those "beings with much feeling and little intelligence " to use his own words. It had been this interest in animal life which led him to study zoology after he had passed his examinations in medicine and attained the degree of M.D. In 1900–1901 he joined an expedition to the Bismark Archipelago. Back in Berlin he entered the staff of the Zoological Garden. In 1911 he planned and erected there the Aquarium which soon became famous the world over.

Heinroth's first revolutionary article on avian psychology appeared in the Proceedings of the Fifth International Ornithological Congress (Berlin, 1910) under the title 'Beiträge zur Biologie, namentlich Ethologie und Psychologie der Anatiden,' but it was almost twenty years before this publication was recognized at its full worth. Other classical papers of his were: 'Beobachtungen bei einem Einbürgerungsversuch mit der Brautente (*Lampronessa sponsa* L.) (Jour. für Ornith., 58: 101–156, 1910); 'Die Beziehungen zwischen Vogelgewicht, Eigewicht, Gelegegewicht und Brutdauer' (Jour. für Ornith., 70: 172–285, 1922); 'Lautäusserungen der Vögel' (Jour. für Ornith., 72: 223–244, 1924).

Fundamental in many ways is the work "Die Vögel Mitteleuropas," published in four volumes from 1926 to 1933 under the joint authorship of Dr. Heinroth and

his wife, Frau Magdalena Heinroth (deceased 1932). Herein were made known the results of the authors' personal studies of almost all the birds breeding within the limits of Germany, which for years the Heinroths had kept in cages and aviaries in their home, where many of them had been reared and closely observed from hatching or shortly thereafter. His excellent little book, 'Aus dem Leben der Vögel' (Berlin, 1938) summarizes the salient points in bird life. Up to his last year of life, Dr. Heinroth continued his many-sided investigations, as proved by the important paper on the homing faculty of the Carrier Pigeon, published by him and his second wife, Dr. Kaethe Heinroth (now Director of the Berlin Zoo), in the Journal für Ornithologie for 1941.

In 1941, when Heinroth had reached the age of 70 (he was born at Kastel near Mainz, March 1, 1871) the Journal für Ornithologie published an anniversary volume (Heinroth-Festschrift) with contributions of some of his most outstanding disciples. This was a tribute to his merits not only as a scientist, but also as President of the Deutsche Ornithologische Gesellschaft, which post he had held since 1926. With his death in Berlin on May 31, 1945, there passed one of the greatest ornithologists of our generation.—E. Stresemann.

Hugh Whistler, a Corresponding Fellow of the American Ornithologists' Union, elected in 1921, died at Battle, Sussex, England, July 7, 1943, in the fifty-fourth year of his life. He was the eldest son of Major Fuller Whistler of the Highland Light Infantry and was born in Mablethorpe, Lincolnshire, England, September 28, 1879. He was educated at Aldenham School and at the age of 20 joined the Indian Police and was assigned to the Province of Punjab, with headquarters at Phillour. In subsequent years he visited all parts of the Punjab from the lower plains to the higher Himalayas, and his interest in birds was a decided advantage in his regular work by causing him to visit many out-of-the-way places. Soon after his arrival in India he entered into correspondence with C. B. Ticehurst and thus began a friendship which lasted until Ticehurst's death. In 1917, during World War I, Ticehurst was serving in the R. A. M. C. at Karachi, and he and Whistler were able to spend their leave together near Simla.

In 1924 Whistler returned to England and made a trip to northern Spain with Ticehurst. During subsequent years they made many trips together to France, Spain, Portugal, North Africa, Albania, Jugoslavia, and Poland. Accounts of several of these trips were published in 'The Ibis.' In 1913 he joined the British Ornithologists' Union and in 1940 served as Vice-President. He also took an active part in local affairs, serving as Secretary to the local committee on Bodian Castle, justice of the peace, and in 1941 as Vice-Chairman of the Battle Rural District Council.

Shortly after his return from India, a plan was made for an illustrated popular book on Indian birds. This book, published in 1928, proved a great success and was republished in three editions. Two years later, with Ticehurst, he planned a systematic account of the birds of India, Burma, and Ceylon, but the death of Ticehurst prevented the consummation of the plan. After his return from a trip to Kashmir with Admiral Lynes he intended to publish an account of the birds of Kashmir and the Punjab, but this, too, remained incomplete. 'The Ibis' for October, 1943, pp. 542–532, contains a biography of Whistler, with a portrait and a bibliography of 145 titles of papers on birds.—T. S. Palmer.

Joseph Warren Jacobs, a Member of the American Ornithologists' Union, died at Waynesburg, Pennsylvania, February 27, 1947, at the age of seventy-eight. He was born on a farm two miles south of Waynesburg, December 5, 1868. At an early

age he became interested in natural history and began to collect nests and eggs of local birds. In 1893 he exhibited his collection at the World's Fair in Chicago and again at the St. Louis Exposition where it was awarded a gold medal. Later he built a museum adjoining his home for its proper installation.

In 1889 Jacobs was elected an Associate of the Union and in 1904 was advanced to the status of a Member. His connection with the Union thus extended over a period of 57 years and was exceeded by that of comparatively few others. He began to contribute to 'The Auk' in 1888 and published occasional notes in subsequent years. He also published a series of papers entitled 'Gleanings' of which a number of issues were printed privately. His interests were centered primarily in the local birds and his two formal papers were devoted to the 'Summer Birds of Green County' (his native county), 1893, and the 'Summer Birds of Monongalia County, West Virginia' (the adjoining county on the south), 1905. Jacobs's name will always be associated with the Purple Martin, a species which was a special favorite of his and its protection his principal hobby. He built martin boxes which had a wide sale and resulted in the organization of the Jacobs Bird House Company to carry on the manufacture of martin boxes on a larger scale. He is survived by his widow and ten children. His interest in wildlife conservation is being continued by one of his sons who is Secretary of the Florida Forest and Parks Association at Tallahassee.—T. S. Palmer.

Richard Magoon Barnes, an Honorary Life Associate of the American Ornithologists' Union, elected in 1889, died at Lacon, Illinois, July 18, 1945, at the age of eighty-three. He was born on April 21, 1862, at Lacon, Marshall County, Illinois, where he spent the greater part of his life. He was educated as a lawyer and for years was local attorney of the Illinois Central Railroad at Lacon. He was greatly interested in oology and brought together a notable collection of nearly 40,000 birds' eggs which he bequeathed to the Chicago Natural History Museum. In recognition of this gift he was elected posthumously a Contributor of the Museum. Several years before his death the collection had been deposited in the Museum where he served as Honorary Curator of Oology.

R. Magoon Barnes, as he usually signed his name, was probably best known as editor and publisher of 'The Oologist' which he conducted for thirty-two years. He acquired the magazine, then in its twenty-sixth volume, in April, 1909, and continued it until December 31, 1941, at the close of volume 58, when he retired as editor at the age of nearly eighty. This journal served as a medium of publication of many notes on eggs and the nesting habits of birds which otherwise might not have been placed on record. The last number contains an interesting autobiography of the editor and a brief review of his connection with 'The Oologist.'—T. S. Palmer.

Russell Messer Berthel, an Associate of the American Ornithologists' Union, elected in 1938, died at Crookston, Minnesota, May 14, 1944. All A. O. U. members who knew him keenly regret the loss to their ranks in his passing. A heart attack suffered while engaged in an upland game bird survey near Crookston cut short his work at the age of but forty-two years. Russell's infectious smile, his perennial good humor, and his eagerness to discuss ornithological questions made his presence always welcome at meetings or on field trips. Unfortunately, he did not fully recognize the depth of his natural history interest until well along in early life. Then, after losing some time in "back tracking" in his training. he was just getting well established in the work he loved at the time of his death. Consequently his passing in early middle age seemed doubly tragic.

Russell M. Berthel was born in St. Paul, Minnesota, on October 11, 1901. His father was a successful dentist in that city. He received his secondary schooling at the St. Paul Academy and at Mechanic Arts High School in St. Paul. In 1923, he entered Hamline University. In the fall of 1925, he transferred to the School of Business at the University of Minnesota. He left the University in his senior year and bought an interest in a company which sold iron and steel products. A few years later he established his own business for the sale of small iron and steel supplies.

Business proved to be a secondary interest with him, however, and he finally made the major decision to devote himself to his chief interest—natural history, and particularly ornithology. He returned to the University and graduated in 1939, and thereafter took graduate work in natural history, at the same time carrying on his iron and steel business. He finally disposed of the business in the fall of 1942, and a few months later became a field biologist for the Minnesota Department of Conservation, remaining in that work until his death. He is survived by his parents, Dr. and Mrs. R. W. Berthel of St. Paul, and his wife, Mary Wheelhouse Berthel of White Bear Lake, Minnesota. His ornithological publications consist of seven articles dealing with field observations and life history notes in the Minnesota Ornithologists' Union publication, *'The Flicker.'*—W. J. Breckenridge.

Otto C. McCreary, an Associate of the American Ornithologists' Union, elected in 1932, died at the age of sixty-four, at Mesa, Arizona, January 6, 1944, while on sick leave from the University of Wyoming. Born in Fishertown, Pennsylvania, September 25, 1879, he received the degree of B. S. from the University of Michigan in 1907 and Ph.D. from Ohio State University in 1926. He served as Assistant Chemist at the New York Experiment Station at Geneva, 1907–1920, and at the Washington State Experiment Station at Pullman, 1920–1922. From 1926 on he was associated with the University of Wyoming as Research Chemist of the Experiment Station where his work dealt chiefly with the forage plants of the state.

Dr. McCreary was an authority on bird migration in the Rocky Mountain region. His publications on birds included two notes in the Reports of the Geological Survey of Michigan for 1905 and 1908, one note in 'The Auk' for 1934, one in the 'Wilson Bulletin' for 1935, and 'Wyoming Bird Life,' 1937.—T. S. Palmer.

John Claude Braly, a Life Associate of the American Ornithologists' Union, was born at McMinnville, Oregon, on October 10, 1875, and died in Portland, Oregon, on November 8, 1944, at the age of sixty-nine. His early education was received in McMinnville, Oregon, and later at San Diego, California.

During his early boyhood days, while living in San Diego, California, he developed a keen interest in birds and like many others of his own age started a collection of eggs. During those years he tramped the fields and hills with A. M. Ingersoll and others who later developed into lifelong ornithologists. Leaving San Diego he went into the automobile business where he soon became representative for one of the well-known automobile manufacturers. Devoting his entire time to a commercial life, his interest in birds waned until he became financially comfortable. When he was about 54 years of age, while renovating his home he discovered a long-forgotten box of birds' eggs. His early interest was suddenly aroused. He at once determined to devote his leisure time to bird study instead of his other recreations which had been trout fishing and duck hunting.

Braly called at my office on a spring day in 1924. This started a close and intimate friendship which lasted to the day of his death. He joined the American Ornithologists' Union, the Cooper Club and the Northwest Bird and Mammal Society. He

read everything he could find relating to birds, he learned to make bird skins and soon became an expert along this line, later mounting many birds in a very lifelike and artistic manner. He travelled widely throughout the west collecting such sets of eggs and birds as were needed to fill gaps in his rapidly growing collection. While Dr. Ira N. Gabrielson and the writer were compiling data for the work on the 'Birds of Oregon,' Braly was one of our closest coöperators. Through his efforts much new information on the nesting of Oregon birds was made available, including such rarities as the Oregon Jay, Clark's Nutcracker, California Pygmy Owl, and several others.

Retiring from active business in 1929, he located at Depoe Bay on the Oregon coast. Here he soon became an active leader among those business men who were developing this seaside resort town. His collection having grown beyond the size of a "home collection," he built and equipped the Braly Museum of Natural History which soon became the headquarters of most of Oregon's bird students as well as thousands of tourists. Shortly before he died the museum became too great a burden on his time so it was moved to Oregon State College at Corvallis, Oregon, where it now is well housed and available for study, not only to students of the college but to visiting ornithologists at large.

Surviving are his wife, Katherine, who was always his sympathetic and very efficient helpmate in all his efforts, and his son, James, besides a host of friends who will long remember his enthusiasm, energy, and liberality. To have known John Claude Braly was a real privilege.—STANLEY G. JEWETT.

HERBERT HUTCHINSON BRIMLEY was born on March 7, 1861, in the village of Willington, County of Bedford, in the midlands section of England. He died April 4, 1946, at Raleigh, North Carolina. His forebears had farmed at Willington for three generations or more, but high rentals and competition with American wheat discouraged the family and they resolved to migrate to Australia or Canada. At this point an immigration agent of the North Carolina Board of Agriculture found the prospects. The result was that the parents with three sons and two daughters arrived in Raleigh in a blizzard on the last day of 1880. The hotel for this night occupied the site where 'Herb' and his brother, Clement, were to make their notable contributions to the zoological sciences of eastern America.

Eight years in the Bedford County School at Elstows, the old home of John Bunyan, constituted Herb Brimley's formal education. He excelled in mathematics, football and swimming. At the end of school he joined an older brother for a clerical job in the iron works, but the lure of the outdoors on another continent drew him away from this. At home near the River Ouse spare time forays for collecting birds and eggs had planted the naturalist seeds.

Near Raleigh the family's attempt at farming the rocky hills was not successful, and Herb fell back on schoolteaching in a one-room log building on the present Meredith College campus. The salary was $30.00 per month for a three-month term. The English accent and unruly pupils combined to make this an unpleasant vocation. Meantime, he had secured a small book, 'Taxidermy Without a Teacher,' and this furnished a guiding impulse. With brother Clem he quickly developed a business of collecting, preparing and selling zoological specimens. At the time the Carolina field was still a new one and the Brimley brothers sent their handiwork to scientists in far places.

Herb soon had a reputation that caused the State Board of Agriculture and Immigration to seek his services in 1884 to mount specimens for the State Centennial Exposition. Similar responsible work followed for the Chicago Exposition (1892),

the Charleston Exposition (1901), the Saint Louis Exposition (1904), the Boston Food Fair (1906) and the Jamestown Exposition (1907).

Meanwhile a vision was nurtured. The Board of Agriculture had a collection of two untidy rooms; called it a museum. In the face of many obstacles, Herb Brimley took charge of this in 1895, at a salary of $75.00 per month, and began the enlargement program to accommodate exhibits coming back from expositions. Literally millions of visitors have come, through the years, from North Carolina and elsewhere to appreciate these exhibits of our Natural History and Natural Resources. For more than sixty years he gave his best to build for his adopted state the leading museum in this section of America. Being a self-taught scholar, he always cherished worth-while publications and built an excellent museum library. In 1941 the Board of Agriculture fittingly designated this as the 'Brimley Library of Natural History.' Further accessions from friends and otherwise have fixed this as a worthy, useful and growing collection.

In his long career, Herb Brimley found time for a hearty participation in social, civic and scientific organizations. He was a founder and life member of the North Carolina Academy of Science, The Raleigh Natural History Club, the Raleigh Bird Club, and the North Carolina Bird Club. He held active memberships in the American Ornithologists' Union, the American Society of Mammalogists, the American Association of Museums, the Museums Association of Great Britain, and the American Museum of Natural History. In all these he has had official position and made original scientific contributions on many occasions. With brother Clem and T. Gilbert Pearson, he was author of the volume on 'Birds of North Carolina' in both the 1919 and 1942 editions. He was an active collaborator with Hugh M. Smith in preparing the volume on 'Fishes of North Carolina' in 1907.

As a citizen, he expressed himself in active leadership in his Rotary Club, his Boy Scout district, and as head of Raleigh's Festival Association, and always he was foremost among those who would conserve the recreational assets of hunting and fishing for North Carolina. His clean sportsmanship was traditional, and he was always sought out as a genial boon companion. He touched the lives of thousands of young people and they perpetuate his tradition.—HARRY T. DAVIS.

LOUIS HOPKINS PORTER. When the 'Birds of Connecticut' appeared in print in 1913, there were several references to specimens of some of the rarer species in the collection of Louis Hopkins Porter. Mr. Porter, an Honorary Life Associate of the A. O. U., died at Stamford, Connecticut, January 18, 1946. He was born in New York City, March 16, 1874. He was graduated from Yale in 1896, and then studied law at Columbia University. He practised law in New York City, and became chief counsel for several large corporations. In 1901 he married Ellen Marion Hatch, who survived him only five months. They had four children.

Mr. Porter was interested in birds from early boyhood, joined the A. O. U. in 1893, made a collection of birds, and published the more unusual records in The Auk. His earlier collection, including the specimens referred to in the 'Birds of Connecticut,' was unfortunately destroyed by fire in 1916, when his house in Stamford was burned. He published nine articles in The Auk, the earliest in 1892 and the last in 1930. After his death his collection of birds, made since 1916, and about thirty volumes of The Auk, were donated to the Stamford Museum.—ARETAS A. SAUNDERS.

WILLIAM EMERSON RITTER, an Associate of the American Ornithologists' Union, elected in 1929, died in Berkeley, California, January 10, 1944, at the age of eighty-seven. Born in Hampden, Wisconsin, November 19, 1856, he was the son of Horatio

and Leonora (Eason) Ritter. He graduated from the State Normal School at Oshkosh, Wisconsin, in 1884, from the University of California in 1888, received his Ph.D. from Harvard University in 1893, and LL.D. from the University of California in 1932. He was a student of the Stazione Zoologica at Naples and at the University of Berlin, 1894–1895. As an undergraduate student, Ritter was somewhat older than most of his classmates and at an age to derive the maximum benefit of university training. At the University of California he came under the influence of two professors, Joseph Le Conte, geologist, and George H. Howison, head of the department of philosophy, both of whom made a marked impression on his subsequent career. Upon graduation he inaugurated postgraduate study in biology under Le Conte but left at the end of the year to continue his work at Harvard. Returning to his alma mater two years later, he became Instructor, 1891–1893, and Assistant Professor of Biology, 1893–1898, Associate Professor of Zoology, 1898–1902, and Professor of Zoology from 1902 until his retirement.

An enthusiastic laboratory worker, Ritter returned from abroad with an ambition to establish a marine biological station on the coast of California. After working at several points he finally located at La Jolla, near San Diego, the laboratory which developed into the Scripps Institution of Oceanography. Active in various fields of scientific work, Ritter served as President of the California Academy of Science from 1898 to 1900, was a member of the Harriman Alaska Expedition in 1899, and later accompanied Mr. E. W. Scripps on several oceanic cruises.

As an author his publications are mainly zoological or philosophical. His chief interest was in the invertebrates, but he devoted some attention to certain west-coast vertebrates. On the subject of birds he will be remembered by his book on 'The California Woodpecker and I,' 1938, in which he sought to explain the social habits of the birds in a colony which he had studied for several years.

Through the personal interest of E. W. Scripps, an organization was developed by the newspapers of the Scripps Syndicate for supplying to the press, in simple language, accurate and complete reports of scientific progress. This organization of which Ritter was Honorary President, is now Science Service, an independent and influential institution in Washington, D. C.

Ritter's three outstanding accomplishments were inauguration of postgraduate biological study at the University of California, establishment of the Scripps Institution of Oceanography, and his efforts to popularize science in the press through Science Service. In 1891 he married Mary E. Bennett, later a successful practicing physician in Berkeley, California, who survived him.—T. S. Palmer.

Edward Alexander Simons.—Tradition means a great deal in Charleston, South Carolina. Though an intangible quality, it is a very living one and its insistent hold through the centuries has depended upon those men and women of culture who have made the city known the world over. Of these there have been many, and high amid that distinguished list are those who have delved into, and followed, the natural sciences. Such names as Gabriel Manigault, Lewis Gibbs, John Bachman and Arthur Wayne come to mind at once. With these professionals however, have been numerous amateurs who perhaps followed science as a hobby but who added materially to it in their quiet, unassuming way. One such was Edward Alexander Simons. The writer was privileged for years to call him friend, and gained much from his kindly character, his intense interest in the outdoors, and his sound advice and companionship.

Edward A. Simons, or "Mr. Eddie" as many of us knew him, an Associate of the American Ornithologists' Union, elected in 1928, was born in Charleston, October 24,

1863, in the midst of that upheaval of misfortune known as the War Between the States. His father was Thomas Grange Simons, Jr., and his mother, Elizabeth Bonneau Noble (Simons). After receiving his education he entered the business of phosphate mining, a great industry in the Carolina Low Country at that time. Years later, however, he left it and became interested in insurance which he sold successfully until he retired.

On January 9, 1890 he married Miss Sara Simonds. Three children were born to them. The eldest, Edward A. Simons, Jr., died as a youngster of five years but the other two survive, these being Sara Calhoun (Mrs. C. Norwood Hastie) and Andrew, a business man of Charleston.

Mr. Eddie was a devoted sportsman, always ready to go afield, but always leaning toward ornithology. He studied birds carefully and his observations and records were of great interest and value to the staff of the Charleston Museum. He was elected a Trustee of that institution in February, 1916, and became its Secretary in March, 1920, holding that position until January, 1928, when he resigned. He was a member of the American Museum of Natural History in New York, and the National Audubon Society. He came frequently into the preparation room of the Charleston Museum during the years the writer was employed there, and together we made many trips afield in the interest of birds, and as companions. Following with enthusiasm the establishment of national and private refuges for wildlife, he was often consulted upon the advisability of areas under consideration and his statements were always accurate and unbiased.

There are many kinds of monuments erected to those who have passed on but some rear monuments as they live. Mr. Eddie has many in the hearts of those who knew and admired him. He died in Charleston, December 23, 1939, and his beloved city thus lost a sincere son, while science lost a devoted adherent, and his family and friends an upright, lovable parent and companion.—ALEXANDER SPRUNT, JR.

HENRY EMERSON TUTTLE.—Those who have been readers of The Auk from as far back as 1919 may remember, in that year, a most interesting article on the drumming of the Ruffed Grouse, accompanied by an excellent photograph of a drumming bird. This article was the work of Henry Emerson Tuttle, an Associate of the A. O. U. from 1909 until his death on March 8, 1946, when he was fifty-five years of age.

Emerson Tuttle was born in Lake Forest, Illinois. His main work in life was in education, teaching English at Westminster School and at Groton. In 1930 he came to Yale, and became Master of Davenport College, his success there being attested when President Seymour spoke of him as "beloved friend of undergraduates."

He had a lifelong interest in birds, wrote about them, photographed them, and sketched them. In the latter part of his life he made etchings, drawings, and paintings of birds which were of such high order that his works are parts of the permanent collections of the Library of Congress, the Metropolitan Museum of Art, the Chicago Art Institute, Yale Art Gallery, the British Museum, and the Bibliothèque Nationale of Paris.

While Tuttle wrote little for The Auk, he had articles published, and illustrated with excellent photographs, in Bird Lore, Outing, Wild Life, the Conservationist and Recreation. His interest in birds was chiefly from the esthetic and artistic sides, rather than the scientific, but his observations are sound, and his writings inspirational, revealing his love of birds and all nature. I have found great pleasure in re-reading his articles in Bird Lore, in the years from 1918 to 1920, and would recommend such reading to others who have access to them. They are ornithological literature at its best.—ARETAS A. SAUNDERS.

NOTES AND NEWS

Mrs. Frederick Hall Fowler, 360 Forest Ave., Palo Alto, California, has advised the Editor that she wishes to dispose of the set of The Auk belonging to the late Mr. Fowler, a former Honorary Life Associate of the A. O. U. This set is complete from volume 1 through volume 53 and includes the Ten-Year Indexes for the first thirty-seven volumes. Volumes 1 to 14 are bound in half-morocco; the remainder are unbound. This is a fine opportunity for someone to obtain a long run of The Auk, the early numbers of which are very difficult to find.

The Editor gratefully acknowledges the generous gift of $250.00 by Member John T. Nichols for the purpose of publishing additional pages in The Auk. This welcome contribution is particularly timely since the number of manuscripts in the files is increasing faster than the publication program admits of their clearance. The gratifying increase in the membership of the A. O. U. carries the added responsibility of providing for additional contributors while increased costs of printing serve as a deterrent. It is earnestly hoped that other friends of the A. O. U. will wish to add to the publication funds and enable the Editor to keep the way open for early appearance of interesting and important manuscripts.

Editorial thanks are again due to Dr. and Mrs. Charles Vaurie for their continued assistance in the preparation of the section on 'Periodical Literature.' The end of the war has brought an increased volume of publications to be scanned and the preparation of the list of titles has become a major task.

A Plea by the A. O. U. Committee for Relief of European Ornithologists

European ornithology is coming to life again. It is a slow and terribly difficult job. Some ornithologists have been forced into other occupations in order to keep their families alive. A few are still prisoners of war. Some are dead. Many libraries are crippled or destroyed. Books and teaching materials are often borrowed or improvised, or done without. With their own hands professors and students are rebuilding their classrooms and laboratories. Even now, there are often no nails to be had, no boards, no window glass—and another winter is coming. In some regions every ornithologist is hungry and inadequately clothed. Some are starving: "Zum Leben zu wenig, zum Sterben zu viel."

These men are our colleagues. Despite such odds, they are making progress. Who among us can fail to admire their courage, and their devotion to our profession? They need our help as well as our respect. They have had some help, from ornithologists in the United States and Canada and from as far as Hawaii and New Zealand, We must do more. Our colleagues abroad are now faced with the approach of another winter. This winter many of them will have even less food than last, even less heat, even less warm clothing with which to fend off the cold in their homes, laboratories, and classrooms. *Food is their most urgent need.* Orders for C. A. R. E. food packages ($4, $10) and Mutual Aid food packages ($3.50, $5.00) may be placed with Mrs. John T. Emlen, 2621 Van Hise Ave., Madison, Wisconsin. Many have asked for used clothing and shoes. Anyone who wishes to send these things can learn where to send them by writing to Mrs. F. N. Hamerstrom Jr., Pinckney, Michigan. She has clothing sizes, foot-tracings, and lists of the individual needs of several hundred European ornithologists and the members of their families. All packages, whether of food or clothing, must be sent at once in order to arrive by early winter.

In comparison with our colleagues' need, who among us has so little that he cannot help?

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